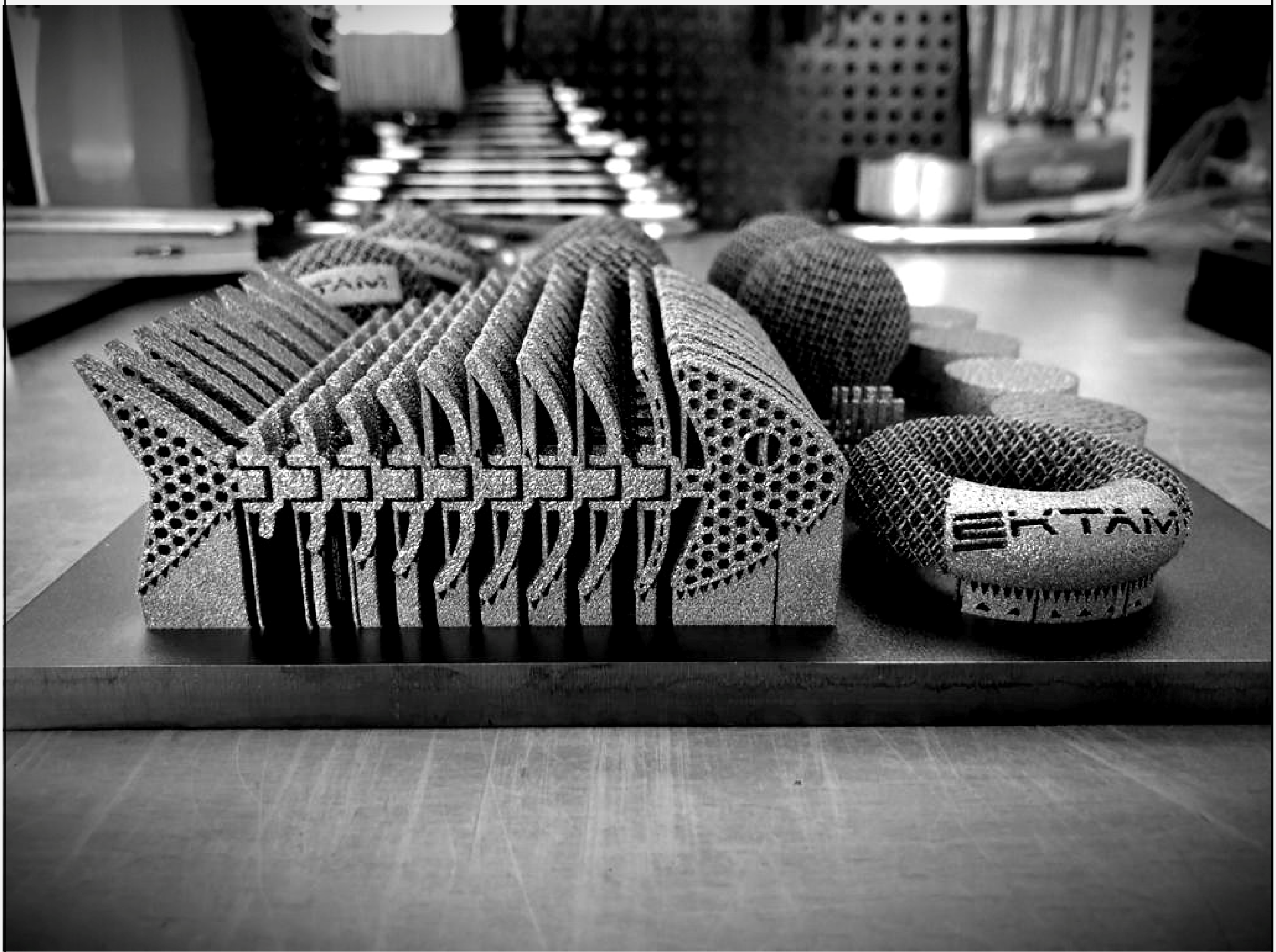
EKTAM



Additive Manufacturing Technology Application and Research Center

ANNUAL REPORT 2021

ADDRESS:

TeknoHAB Technology Development Zone Manager Inc.

Akıncı Mahallesi TUSAŞ Bulvar No:1

Kahramankazan/ANKARA

E-Mail: ektam@gazi.edu.tr

FOREWORD

PROF. METİN UYMAZ SALAMCI

DIRECTOR / CHAIRMAN OF THE BOARD

Additive manufacturing technologies are among the strategic technologies that are handled as a priority all over the world because of its many advantages, especially design flexibility. As the development and use of this technology has become evident in recent years, the interest of industries and universities to additive manufacturing technologies in our country has increased with impressive acceleration and trend. The contribution of our country to additive manufacturing technologies in recent years yielded in different ways such as the development of technology, the localization of additive manufacturing machines, the introduction of the original design into production, and it has become evident in the international field.

On the one hand, Gazi University is following the improvement of the technologies in the world and also established the Additive Manufacturing Technologies Application and Research Center (EKTAM). EKTAM is structured to be the national center of excellence that all industrial institutions and universities in the country will benefit from itself. Based on metal and ceramic materials, we are working with industry organizations for both material research and 3D printer technologies. EKTAM is positioned in the TeknoHAB Technology Development Zone in order to facilitate the collaboration of the university and the industry and to provide high value-added products. Thus, the accessibility of the additive manufacturing research infrastructure, which is important for our country, is provided by both the university and the industry.

While applying to scientific support programs such as TÜBİTAK 1004, SAYEM and COFUND with collaborative platforms, the center has created national and international projects as well. EKTAM contributes to the qualified manpower resource for our country's needs with its full-time doctoral program.

The effectiveness of EKTAM in the field of additive manufacturing technologies will be more evident at technology development services, high value-added product development in the upcoming years.

CONTENTS

○ ABOUT EKTAM

Gazi University, established the Additive Manufacturing Technologies Application and Research Center (EKTAM) in the lead of developments in the world. EKTAM is positioned in the TechnoHAB Technology Development Zone in order to facilitate the cooperation of the university and the industry and to obtain high value-added products.

EKTAM has been structured as a national center of excellence from which all industrial establishments and universities will benefit. EKTAM's contributions in the field of additive manufacturing technologies, high value-added product developments and manpower resources are becoming more evident. EKTAM will continue to serve more effectively in the status of a National Center of Excellence for our country.

○ EKTAM MISSION

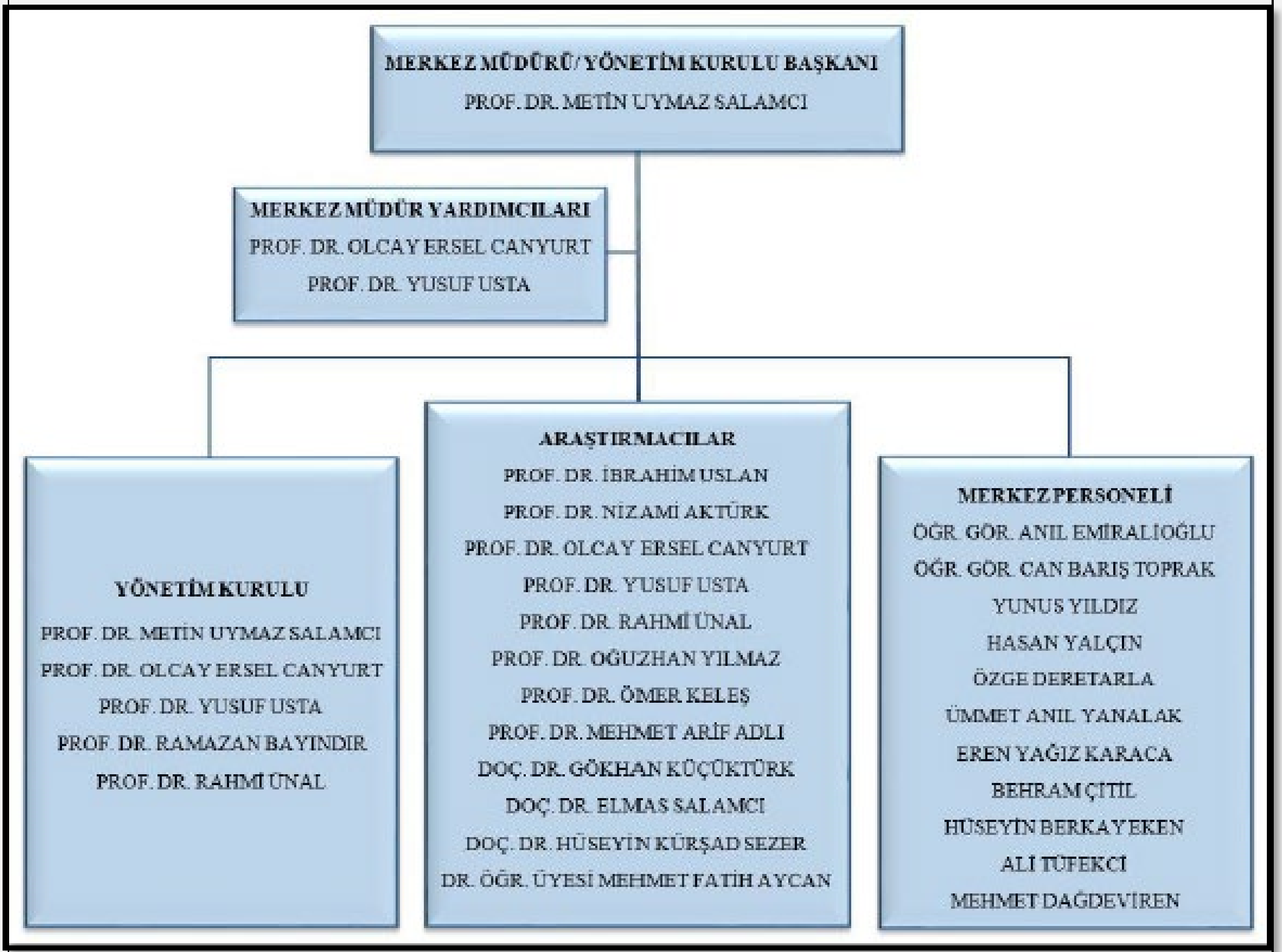
To meet the trained personnel needs of our country in the field of new generation manufacturing technologies, to be a pioneer in the use of advanced manufacturing technologies by the country's industry and to contribute to the university-industry cooperation by ensuring that all stakeholders benefit from the established infrastructure in the most effective way.

○ EKTAM VISION

To be a national excellence center that guides developments in the scientific field, is innovative, pioneering, creates value and is based on excellence, sets an example for our country and can compete with centers established abroad for the same purposes as a national center of excellence.


GAZİ ÜNİVERSİTESİ
1926
EKTAM

ORGANIZATION CHART



○ EXECUTIVE SUMMARY

Additive manufacturing technologies are among the strategic technologies that are prioritized all over the world due to their many advantages, especially the design flexibility. With the development and use of this technology in recent years, industry and university's interest in additive manufacturing technologies has increased with a increasing acceleration and trend. The contributions of our country to additive manufacturing technologies in recent years are developing of technology, the localization of additive manufacturing machines, the production of the original design and becoming prominent in the international arena.

Based on metal and ceramic materials, EKTAM is working with industrial organizations for both basic research and development of products up to Technology Readiness Level 6 in material research and 3D printer technologies. EKTAM is positioned in the TechnoHAB Technology Development Zone in order to facilitate the cooperation of the university and the industry and to obtain high value-added products. The accessibility of additive manufacturing research

infrastructure, which is important for our country, is opened to the university and the industry.

EKTAM aims to participate in TUBITAK's 1004 and SAYEM programs with the platforms it has created. While conducting product-based studies in strong collaborations with industry, it also tries to contribute to the qualified manpower resource that our country needs with its full-time doctorate program.

The activities of EKTAM in the field of additive manufacturing technologies of our country are the technology development services, high value-added product development and contribution to qualified manpower resources. They become more and more prominent under the these headings. Depending on its serve more effectively in the status of a National Center of Excellence for our country.

○ AIMS AND GOALS

The general aims of the center are:

- ✓ Conducting scientific, technological and applied research in order to ensure the development of new generation additive manufacturing technologies,
- ✓ Supporting additive manufacturing technologies; to develop new metal, ceramic powder and powder alloys, to use laser and electron beam technologies, to develop optical and image processing methods, and to conduct scientific and applied research in other fields,
- ✓ Improving the production and application capacity of different original products by using and improving additive manufacturing technologies,
- ✓ To expand the additive manufacturing product range and product boundaries; to design and manufacture more precise and ready-to-use products,
- ✓ To cooperate with private industry and public institutions and to carry out joint R&D activities in order to develop domestic and original additive manufacturing production benches and subsystems,
- ✓ Developing the software required for additive manufacturing technologies and Industry 4.0 through joint R&D activities in cooperation with private sector and public institutions,

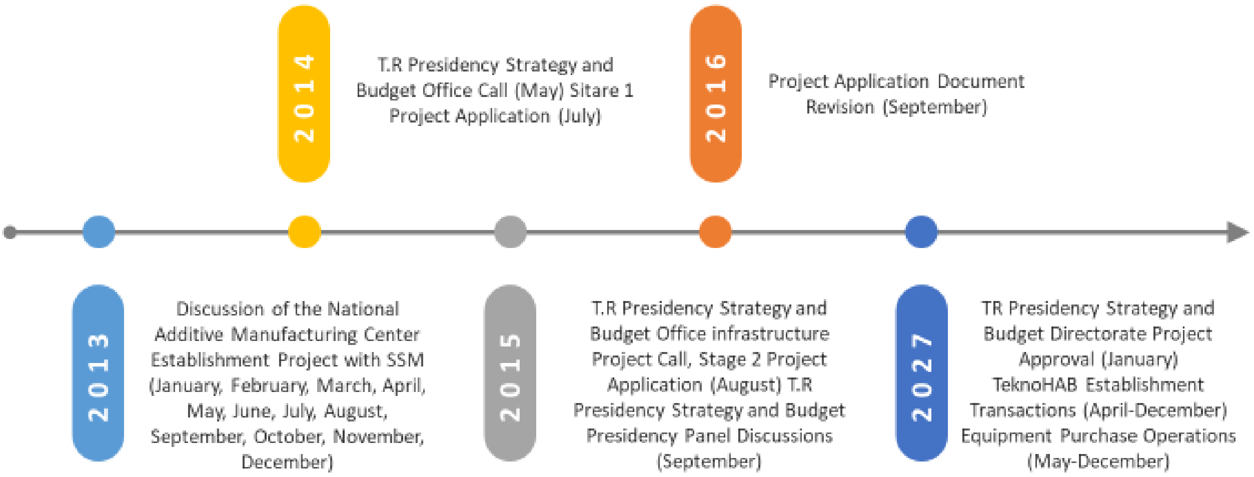
- ✓ To ensure the creation of application areas with the development of metal deposition technologies, to make applications and studies in the repair-maintenance-technologies of jet and gas turbine engine parts in the aviation sector,
- ✓ Conducting joint research projects, collaborating and exchanging researchers with domestic and international stakeholder universities and research centers,
- ✓ To provide training programs and certified trainings for industrial workers in order to train qualified manpower required by the industry, to contribute by offering to open industry-oriented master's and engineering doctoral programs,
- ✓ Organizing workshops, organizing national / international conferences and publishing scientific periodicals in order to ensure the development and progress of additive manufacturing technologies in our country.

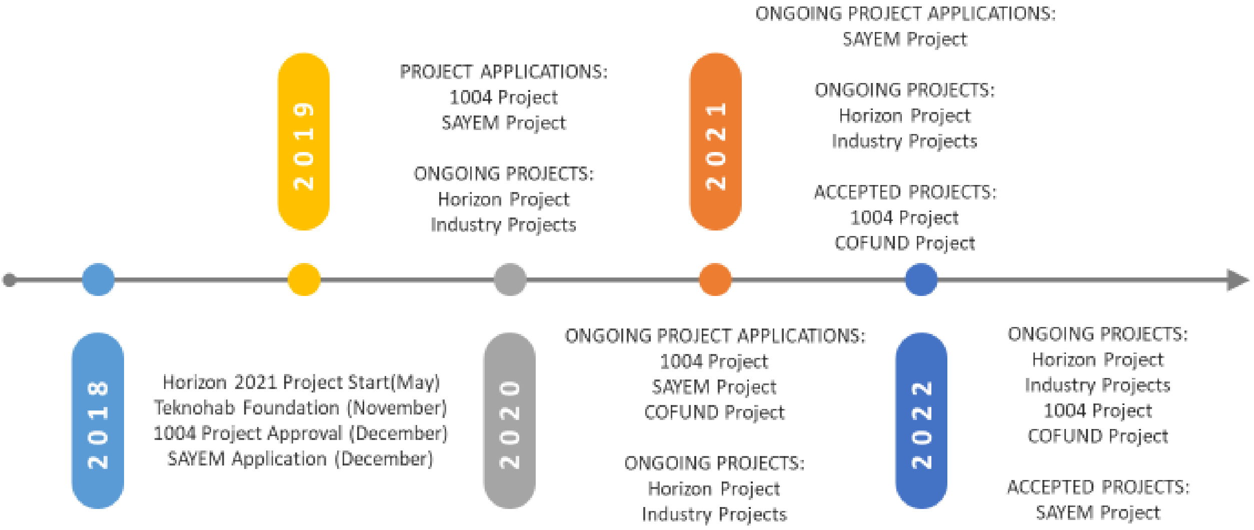
Targeted Socio-Economic And Scientific Benefits

- ✓ Being sensitive to the environment,
- ✓ Enabling the use of bio-based products and sustainable materials,

- ✓ To enable the use of more than one material and changing structures depending on the function,
- ✓ Speeding up the custom manufacturing process,
- ✓ Increasing processing precision,
- ✓ To reduce energy and material consumption,
- ✓ To reduce waste.

○ HISTORY OF EKTAM





2018
Horizon 2021 Project Start(May)
Teknohab Foundation (November)
1004 Project Approval (December)
SAYEM Application (December)
2019
PROJECT APPLICATIONS:
1004 Project
SAYEM Project
ONGOING PROJECTS:
Horizon Project
Industry Projects
2020
ONGOING PROJECT APPLICATIONS:
1004 Project
SAYEM Project
COFUND Project
ONGOING PROJECTS:
Horizon Project
Industry Projects
2021
ONGOING PROJECT APPLICATIONS:
SAYEM Project
ONGOING PROJECTS:
Horizon Project
Industry Projects
ACCEPTED PROJECTS:
1004 Project
COFUND Project
2022
ONGOING PROJECTS:
Horizon Project
Industry Projects
1004 Project
COFUND Project
ACCEPTED PROJECTS:
SAYEM Project

○ PARTNERS

UNIVERSITIES	Yıldız Teknik Üniversitesi; Erzurum Teknik Üniversitesi; Gebze Teknik Üniversitesi; İzmir Yüksek Teknoloji Enstitüsü; Sabancı Üniversitesi; Sağlık Bilimleri Üniversitesi; TOBB Ekonomi ve Teknoloji Üniversitesi; İstanbul Zaim Üniversitesi; ODTÜ; İstanbul Teknik Üniversitesi; Michigan State University; AGH; Българска Академия на Науките; Universidad Carlos III de Madrid; SDU University of Southern Denmark
INDUSTRY PARTNERS	Türk Havacılık Uzay Sanayii; TEI; aselsan; roketsan; FNSS; ERMAKSAN; FIT Additive Manufacturing Group; 3DLAB; EMT Electronics
SUPPORTING INSTITUTIONS	T.C. Cumhurbaşkanlığı Strateji ve Bütçe Başkanlığı; T.C. Cumhurbaşkanlığı Savunma Sanayii Başkanlığı

○ BILATERAL AGREEMENTS BETWEEN UNIVERSITIES

Agreements Between Abroad Universities

UNIVERSITY NAME	CONTENT OF THE AGREEMENT
Michigan State University- MSU	Çift Danışmanlı Doktora Programı (Plan Aşamasında)
AGH University of Science and Technology	TÜBİTAK 1004 Project, Joint Projects and Studies
Bulgarian Academy of Sciences	Joint Projects and Studies
- Carlos III University of Madrid - University of Southern Denmark- Mads Clausen Institute	COFUND Program

Agreements with Domestic Universities and Companies

UNIVERSITY AND COMPANY NAME	CONTENT OF THE AGREEMENT
ASELSAN Electronic Industry and Trade Inc. ERMAKSAN Machinery Industry and Trade Inc. Erzurum Technical University ROKETSAN Rocket Industry and Trade Inc. Sabanci University TUSAŞ- Turkish Aerospace Industries Inc. TUSAS Engine Industry Inc.-TEI TUBITAK Marmara Research Center-MAM FIT Additive Manufacturing Group (Germany) 3D LAB (Poland)	TÜBİTAK 1004 Project

AGH Science and Technology University (Poland)	
Gebze Technical University TOBB ETU İstanbul Sabahattin Zaim University	Partnership Agreement
EMT Electronics	Cooperation Protocol
Middle East Technical University Istanbul Technical University Izmir Institute of Technology FIT Additive Manufacturing Group (Germany) TUSAŞ- Turkish Aerospace Industries Inc. ERMAKSAN Makina Sanayi Ve Ticaret A.Ş. TeknoHAB Technology Development Zone	COFUND Program


EKTAM

PROF. DR. METİN UYMAZ SALAMCI

B.Sc.- Gazi University, Mechanical Engineering, 1982

M.Sc. - METU, Mechanical Engineering, 1986

Ph.D. - METU, Mechanical Engineering, 1999

Areas of Interest: Unconventional manufacturing methods, Machine Theory and Dynamics, Machine Dynamics, System Dynamics and Control, Mechatronics, Modeling and Simulation of Dynamic Systems, Mechanical Vibrations

Some Publications:

A. H SOFİYEV, B E. TURKASLAN, R P BAYRAMOV & M. U. SALAMCİ, Analytical solution of stability of FG-CNTRC conical shells under external pressures, ThinWalled Structures, 2019, 02638231, 144, 106338.

N. BABAEİ & M. U. SALAMCİ, Controller Design For Personalized Drug Administration In Cancer Therapy: Successive Approximation Approach, Optimal Control Applications and Methods, 2018, 01432087, 39, 2, 682-719.

F. KARA & M. U. SALAMCİ, Model Reference Adaptive Sliding Surface Design For Nonlinear Systems, IEEE Transactions on Industry Applications, 2018, 0093-9994, 54, 1, 611-624.

B. M. KOCAGİL, A. Ç. ARICAN, M. U. SALAMCİ, Ü. M. GÜZEY & S. ÖZCAN, Controller Designs For Nonlinear Systems With Application To 3 Dof Helicopter Model, Gazi University Journal of Science Part A: Engineering and Innovation, 2017, 2147- 9542, 4, 3, 47-66.

H. KAMİŞLİ, B. ÖZKAN & M. U. SALAMCİ, Precise Control Of An Electromechanically-actuated Launcher Under Parameter Uncertainty, ANADOLU UNIVERSITY JOURNAL OF SCIENCE AND TECHNOLOGY A - Applied Sciences and Engineering, 2017, 1302-3160, 18, 4, 788-803.

PROF. DR. OLCAY ERSEL CANYURT

B.Sc.- Gazi University, Mechanical Engineering, 1992

M.Sc. - Northeastern University, 1995

Ph.D. - Rensselaer Polytechnic Institute, 2002

Areas of Interest: Machine Engineering, Mechanical, Solid Mechanics, Finite Element Method, Mechanical Tests

Some Publications:

THE EFFECT OF PENTAGONAL AND OCTAGONAL JOINT DESIGN ON THE FATIGUE STRENGTH OF POLYMER-MATRIX COMPOSITE MATERIALS ERSAN Ç., CANYURT O. E. MATERIALI IN TEHNOLOGIJE, cilt.54, ss.143-148, 2020 (Journal Indexed in SCI)

The Effect of Nanoparticle Additive on the Mechanical Properties of Glass Fiber Composite Materials Tuncer C., Canyurt O. E. ACTA PHYSICA POLONICA A, cilt.135, ss.752-755, 2019 (Journal Indexed in SCI)

A new approach for calculating the stiffness of bolted connections Canyurt O. E. , Sekercioglu T. PROCEEDINGS OF THE INSTITUTION OF MECHANICAL ENGINEERS PART L-JOURNAL OF MATERIALS-DESIGN AND APPLICATIONS, cilt.230, ss.426-435, 2016 (Journal Indexed in SCI)

Optimization of strength of friction stir welded joints for AISI 430 ferritic stainless steels by genetic algorithm Bilgin M. B. , Meran C., Canyurt O. E. INTERNATIONAL JOURNAL

OF ADVANCED MANUFACTURING TECHNOLOGY, cilt.77, ss.2221-2233, 2015 (Journal Indexed in SCI)

Development of the positive mean stress diagrams using genetic algorithm approach Sekercioglu T., Canyurt O. E. FATIGUE & FRACTURE OF ENGINEERING MATERIALS & STRUCTURES, cilt.37, ss.306-313, 2014 (Journal Indexed in SCI)

PROF. DR. YUSUF USTA

B.Sc. - Gazi University, Mechanical Engineering, 1989

M.Sc. - Gazi University, Mechanical Engineering, 1992

Ph.D. - Gazi University, Mechanical Engineering, 1999

Areas of Interest: Additive Manufacturing, Powder Metallurgy Manufacturing Procedures, Computer Aided Design and Manufacturing, Material Science

Some Publications:

Reproducibility of Replicated Trabecular Bone Structures from Ti6Al4V Extralow Interstitials Powder by Selective Laser

Melting, Balci A., Kucukaltun F., Aycan M.F., Usta Y., Demir T. Arabian Journal for Science and Engineering, 2021.

Establishment of an incentive system for press machine tools used in metal manufacturing industry for increasing the safety according to occupation safety, Pehlivan T., Usta Y., Journal of The Faculty of Engineering and Architecture of Gazi University, cilt.35, ss.1751-1765, 2020.

Experimental Investigation Effects of Parameters of Spray Formation on Porosity and Hardness, Hasak S. M. A., Usta Y., Atomization and Sprays, cilt.29, ss.783-797, 2019.

Investigation of toggling effect on pullout performance of pedicle screws Aycan M. F., Yaman M.E., Usta Y., Demir T., Tolunay T., Proceedings of The Institution of Mechanical Engineers Part H-Journal of Engineering in Medicine, cilt.232, ss.395-402, 2018.

Investigation of the Effect of Mechanical Properties of Electron Beam Melting Process and Production Orientation, B. Sen, Master Y., 1st National Congress of Engineering and Technology, Karaman, Turkey, 17 - October 19, 2019, ss.4.

PROF. DR. YAŞAR AYDEMİR

B.Sc. - Gazi University, Elecrical Education, 1992

M.Sc. - Gazi University, Electrical Education, 1998

Ph.D. - Gazi University, Electrical Education, 2002

Areas of Interest: Artificial Intelligence, Smart Grids, Microgrids, EV, Industrial Automation

Some Publications:

Review of multilevel voltage source inverter topologies and control schemes, I Colak, E Kabalci, R Bayindir, Energy conversion and management, 52 (2), 1114-1128

Microgrid testbeds around the world: State of art, E Hossain, E Kabalci, R Bayindir, R Perez, Energy Conversion and Management 86, 132-153

Smart grid technologies and applications, R Bayindir, I Colak, G Fulli, K Demirtas, Renewable and sustainable energy reviews 66, 499-516

A comprehensive study on microgrid technology, R Bayindir, E Hossain, E Kabalci, R Perez, International Journal of Renewable Energy Research (IJRER) 4 (4), 1094-1107

A water pumping control system with a programmable logic controller (PLC) and industrial wireless modules for industrial plants—An experimental setup, R Bayindir, Y Cetinceviz, ISA transactions 50 (2), 321-328

PROF. DR. RAHMİ ÜNAL

B.Sc. - METU, Mechanical Engineering, 1991

M.Sc. - Gazi University, Mechanical Engineering, 1995

Ph.D.- Technische Universitaet Clausthal, Material Science And Engineering, 1999

Areas of Interest: Machine Engineering, Construction and Manufacturing, Metallurgy and Materials Engineering, Material Science and Engineering

Some Publications:

Numerical and Experimental Investigation on the Effects of a Nozzle Attachment to Plasma Torches for Plasma Atomization, Yurtkuran E., Ünal R. PLASMA CHEMISTRY AND PLASMA PROCESSING, cilt.40, ss.1127-1144, 2020

Investigation of the Mechanical, Electronic and Phonon Properties of X2ScAl (X = Ir, Os, and Pt) Heusler Compounds, ARIKAN N., OCAK H. Y. , YILDIZ G. D. , YILDIZ Y. G. , ÜNAL R. JOURNAL OF THE KOREAN PHYSICAL SOCIETY, cilt.76, ss.916-922, 2020

Experimental and numerical study of Stairmand cyclone separators: a comparison of the results of small-scale and large-scale cyclones Erol H. I. , TURGUT O. , ÜNAL R. HEAT AND MASS TRANSFER, cilt.55, ss.2341-2354, 2019

Numerical modeling of torch design for plasma atomization, Yurtkuran E., Unal R. , Ozsunar A. Acta Physica Polonica A, cilt.134, ss.292-296, 2018

Determination of metal powder particle size by numerical modeling in gas atomization, Kayali Y. E. , Ünal R. JOURNAL OF THE FACULTY OF ENGINEERING AND ARCHITECTURE OF GAZI UNIVERSITY, cilt.33, ss.1135-1144, 2018

PROF. DR. İBRAHİM USLAN

B.Sc. - Gazi University, Mechanical Engineering, 1988

M.Sc. - Gazi University, Mechanical Engineering, 1993

Ph.D. - Gazi University, Mechanical Engineering, 1999

<u>Some Publications:</u>

Thermo-fluid multi-physics modeling and experimental verification of volumetric workpiece material removal by a discharge pulse in electric discharge machining process, ERDEM O., ÇOĞUN C., USLAN İ. , ERBAŞ M. JOURNAL OF PHYSICS D-APPLIED PHYSICS, cilt.53, 2020

Proposal of a mathematical model for describing magnetorheological fluid dynamic behavior, DOĞDU N., USLAN İ. , Yuksel S., PARLAK Z. JOURNAL OF MECHANICAL SCIENCE AND TECHNOLOGY, cilt.33, ss.3885-3893, 2019

Performance and surface alloying characteristics of Cu-Cr and Cu-Mo powder metal tool electrodes in electrical discharge machining, Gulcan O., USLAN İ. , USTA Y. , ÇOĞUN C.

MACHINING SCIENCE AND TECHNOLOGY, cilt.20, ss.523-546, 2016

The effect of powder mixed and heated dielectric on drilling performance of electric discharge machining (EDM), Erdem O., ÇOĞUN C., Urtekin L., ÖZERKAN H. B. , USLAN İ. JOURNAL OF THE FACULTY OF ENGINEERING AND ARCHITECTURE OF GAZI UNIVERSITY, cilt.31, ss.531-544, 2016

EFFECT OF USE OF Cu-Cr P/M ELECTRODES ON MACHINING PERFORMANCE OF ELECTRIC DISCHARGE MACHINING, Gulcan O., USLAN İ. , USTA Y. , ÇOĞUN C. JOURNAL OF THE FACULTY OF ENGINEERING AND ARCHITECTURE OF GAZI UNIVERSITY, cilt.30, ss.381-394, 2015

PROF. DR. NİZAMİ AKTÜRK

B.Sc. - Gazi University, Mechanical Engineering, 1986

M.Sc. - University of London, Mechanical Engineering, 1989

Ph.D. - University of London, Mechanical Engineering, 1993

<u>Some Publications:</u>

Vibration modeling of wind turbine shaft as rigid shaft supported by EHL contact ball bearings with overhung disc system, Bal H., AKTÜRK N. TRIBOLOGY INTERNATIONAL, cilt.151, 2020

Effect of powder metallurgy Cu-B4C electrodes on workpiece surface characteristics and machining performance of electric discharge machining, ÇOĞUN C., ESEN Z., GENÇ A. , Cogun F., AKTÜRK N. PROCEEDINGS OF THE INSTITUTION OF MECHANICAL ENGINEERS PART B-JOURNAL OF ENGINEERING MANUFACTURE, cilt.230, ss.2190-2203, 2016

Iterative Optimal Control for Flexible Rotor-AMB System, Tombul G. S. , Banks S. P. , AKTÜRK N. ACTA MONTANISTICA SLOVACA, cilt.15, ss.9-13, 2010

Sliding mode control for a class of non-affine nonlinear systems, Tombul G. S. , Banks S. P. , AKTÜRK N. NONLINEAR ANALYSIS-THEORY METHODS & APPLICATIONS, cilt.71, 2009

MODELING OF VIBRATIONS CAUSED BY LOCALIZED DEFECTS IN BALL BEARINGS, KARAÇAY T. , AKTÜRK N. JOURNAL OF THE FACULTY OF ENGINEERING AND ARCHITECTURE OF GAZI UNIVERSITY, cilt.24, ss.191-197, 2009

PROF. DR. OĞUZHAN YILMAZ

B.Sc. - Gaziantep University,

Materials and Manufacturing Engineering, 1997

M.Sc. - Gaziantep University, Mechanical Engineering, 1999

Ph.D. - University of Nottingham, Mechanical Engineering 2006

Areas of Interest: Machine Elements, Computer Aided Design and Manufacturing, Unconventional manufacturing methods

Some Publications:

Wire arc additive manufacturing of high-strength low alloy steels: study of process parameters and their influence on the bead geometry and mechanical characteristics, Yildiz A. S. , Davut K., Koc B., Yılmaz O. INTERNATIONAL JOURNAL OF ADVANCED MANUFACTURING TECHNOLOGY, cilt.108, ss.3391-3404, 2020

Experimental investigation of the effects of dedicated electrochemical machining parameters on freeform surface machining, Demirtas H., YILMAZ O. , Kanber B. JOURNAL OF MANUFACTURING PROCESSES, cilt.43, ss.244-252, 2019

Controlling short circuiting, oxide layer and cavitation problems in electrochemical machining of freeform surfaces, DEMİRTAŞ H., YILMAZ O. , KANBER B. JOURNAL OF MATERIALS PROCESSING TECHNOLOGY, cilt.262, ss.585-596, 2018

Development and control of shaped metal deposition process using tungsten inert gas arc heat source in additive layered manufacturing, Ugla A. A. , YILMAZ O. , Almusawi A. R. J. PROCEEDINGS OF THE INSTITUTION OF MECHANICAL ENGINEERS PART B-JOURNAL OF ENGINEERING MANUFACTURE, cilt.232, ss.1628-1641, 2018

A simplified mathematical model development for the design of free-form cathode surface in electrochemical machining, DEMİRTAŞ H., YILMAZ O. , KANBER B. MACHINING SCIENCE AND TECHNOLOGY, cilt.21, ss.157-173, 2017

PROF. DR. ÖMER KELEŞ

B.Sc. - Gazi University, Mechanical Engineering, 1989

M.Sc. - Gazi University, Mechanical Engineering, 1992

Ph.D. - Gazi University, Mechanical Engineering, 1998

Areas of Interest: Machine Engineering, Construction and Manufacturing, Machine Theory and Dynamics, Engineering and Technology

Some Publications:

Additive manufacturing of Ti-alloy: Thermal analysis and assessment of properties, KELEŞ Ö. , Shuja S. Z. , Yilbas B. S. , Al-Qahtani H., Hassan G., Adesina A. Y. , et al. ADVANCES IN MECHANICAL ENGINEERING, cilt.12, 2020

Magneto-rheological engine mount design and experimental characterization, Turkucu T., KELEŞ Ö. JOURNAL OF MECHANICAL SCIENCE AND TECHNOLOGY, cilt.32, ss.5171-5178, 2018

Laser cutting of triangular geometry into 2024 aluminum alloy: Influence of triangle size on thermal stress field, Yilbas B. S. , Akhtar S. S. , KELEŞ Ö. , BORAN K. JOURNAL OF MECHANICAL SCIENCE AND TECHNOLOGY, cilt.29, ss.3239-3248, 2015

Laser cutting of small diameter hole in aluminum foam, Yilbas B. S. , Akhtar S. S. , KELEŞ Ö. INTERNATIONAL JOURNAL OF ADVANCED MANUFACTURING TECHNOLOGY, cilt.79, ss.101-111, 2015

Laser cutting of rectangular geometry in 2024 aluminum alloy: Thermal stress analysis, Kardas O. O. , KELEŞ Ö. , Akhtar S., Yilbas B. S. OPTICS AND LASER TECHNOLOGY, cilt.64, ss.247-256, 2014

PROF. DR. MEHMET ARİF ADLI

B.Sc. - METU, Mechanical Engineering, 1986

M.Sc. – Ritsumeikan University, Mechanical Engineering, 1990

Ph.D. - Ritsumeikan University, Mechanical Engineering, 1993

Some Publications:

Pole placement and LQR control of slosh-free liquid transportation with dual-arm cooperative robot, Soufiani B. N. , ADLI M. A. JOURNAL OF THE FACULTY OF ENGINEERING AND ARCHITECTURE OF GAZI UNIVERSITY, cilt.35, ss.2255-2267, 2020

Kinematic and Dynamic Analysis of a Parallel Platform with Three Degrees of Freedom Providing Pure Orientational Movements, İNAL R. U., ADLI M. A., ÖZKAN B. Selcuk University Journal of Engineering Science and Technology, vol.18, pp.14-32, 2019

Comparative evaluation of EMG signal features for myoelectric controlled human arm prosthetics, Karabulut D., Ortes F., Arslan Y. Z. , ADLI M. A. BIOCYBERNETICS AND BIOMEDICAL ENGINEERING, cilt.37, ss.326-335, 2017

Design and Implementation of a Thrust Vector Control (TVC) Test System, Unal A., Yaman K., Okur E., ADLI M. A. JOURNAL OF POLYTECHNIC-POLITEKNIK DERGISI, cilt.21, ss.497-505, 2018

Compliance Control and Selective Compliance Center via Internal Forces in Redundantly Actuated Closed Chain Mechanisms ADLI M. A. , Hideo H. Transactions of the Society of Instrument and Control Engineers(SICE), cilt.29, ss.253-262, 1993

ASSOC. PROF. DR. GÖKHAN KÜÇÜKTÜRK

B.Sc. – Kocaeli University, Mechanical Engineering, 2000

M.Sc. - Gebze Institute of Technology, Material Science And Engineering, 2003

Ph.D. – Gazi University, Mechanical Engineering, 2008

Areas of Interest: Machine Elements, Casting Methods, Unconventional Manufacturing Methods, Welding Methods, Material, Plastic Forming Methods, Machining Methods, Engineering and Technology

Some Publications:

Effect of electrical discharge machining on dental Y-TZP ceramic-resin bonding, Rona N., YENİSEY M., KÜÇÜKTÜRK G. , GÜRÜN H. , ÇOĞUN C., ESEN Z. JOURNAL OF PROSTHODONTIC RESEARCH, cilt.61, ss.158-167, 2017

Effect of matrix temperature and powder size on the infiltration height of SiO2-reinforced Al 7075 matrix composites produced by vacuum infiltration, ÇALIN R., PUL M., BİCAN O., KÜÇÜKTÜRK G. SCIENCE AND ENGINEERING OF COMPOSITE MATERIALS, cilt.24, ss.149-153, 2017

The effect of minimum quantity lubrication under different parameters in the turning of AA7075 and AA2024 aluminium alloys, Cakir A., YAĞMUR S. , Kavak N., KÜÇÜKTÜRK G. , Seker U. INTERNATIONAL JOURNAL OF ADVANCED MANUFACTURING TECHNOLOGY, cilt.84, ss.2515-2521, 2016

An Investigation of Thermal Properties of Zirconia Coating on Aluminum, URTEKİN L., KÜÇÜKTÜRK G. , KARAÇAY T. , USLAN İ. , SALMAN S. ARABIAN JOURNAL FOR SCIENCE AND ENGINEERING, cilt.37, ss.2323-2332, 2012

Effects of reinforcement volume fraction on the abrasive wear behaviour of Al-MgO composites produced by the vacuum infiltration method, Pul M., KÜÇÜKTÜRK G. , Calin R., Seker U. PROCEEDINGS OF THE INSTITUTION OF

MECHANICAL ENGINEERS PART J-JOURNAL OF ENGINEERING TRIBOLOGY, cilt.225, ss.84-90, 2011

ASSOC. PROF. DR. ELMAS SALAMCI

B.Sc. – İstanbul Technical University,

Metallurgy and Materials Engineering,1988

Integrated Ph.D. - University of Leeds, School Of Materials, 1998

Some Publications:

The effects on the flexural strength and impact behavior of nanographene ratio of the glass fiber nanocomposite plates, Khakzad F., TÜZEMEN M. Ç. , SALAMCİ E. , Anil O. POLYMER ENGINEERING AND SCIENCE, vol.59, pp.2082-2091, 2019

Enhancing mechanical properties of bolted carbon/epoxy nanocomposites with carbon nanotube, nanoclay, and hybrid loading, TÜZEMEN M. Ç. , SALAMCİ E. , AVCI A.

COMPOSITES PART B-ENGINEERING, vol.128, pp.146-154, 2017

Effect of microstructure on high cycle fatigue behavior of high martensitic dual phase steels Saatci T., SALAMCİ E. MATERIALS TESTING, vol.59, pp.315-322, 2017

Investigation of corrosion behaviour of porous powder metallurgy parts electrochemically coated with diamond nano particles modified chromium, Bilgili E. Z. , SALAMCİ E. , ASAN A., ÜNAL R. , Valov R. JOURNAL OF THE FACULTY OF ENGINEERING AND ARCHITECTURE OF GAZI UNIVERSITY, vol.31, pp.580-589, 2016

Investigation of Corrosion Behavior of Powder Metallurgy Materials Produced From DistaloyAB Powders and Electrochemically Coated Chromium With Diamond Nanopartical Additive, Bilgili E. Z. , SALAMCİ E. , ASAN A. JOURNAL OF POLYTECHNIC-POLITEKNIK DERGISI, vol.20, pp.223-230, 2017

ASSOC. PROF. DR. HÜSEYİN KÜRŞAD SEZER

B.Sc. - Erciyes University, Mechanical Engineering, 2001

Integrated Ph.D. - The University of Manchester, Mechanical Engineering, 2007

<u>Some Publications:</u>

Additive manufacturing of carbon fiber reinforced plastic composites by fused deposition modelling: effect of fiber content and process parameters on mechanical properties, SEZER H. K. , EREN O. , BÖRKLÜ H. R. , ÖZDEMİR V. JOURNAL OF THE FACULTY OF ENGINEERING AND ARCHITECTURE OF GAZI UNIVERSITY, cilt.34, ss.664-674, 2019

FDM 3D printing of MWCNT re-inforced ABS nano-composite parts with enhanced mechanical and electrical properties, SEZER H. K. , EREN O. JOURNAL OF MANUFACTURING PROCESSES, cilt.37, ss.339-347, 2019

The design process of the complex Special Utility Vehicle using the methodical design approach, Cavdar F. Y. , BÖRKLÜ H. R. , ÇAVDAR K., SEZER H. K. JOURNAL OF ADVANCED MECHANICAL DESIGN SYSTEMS AND MANUFACTURING, cilt.13, 2019

Performance of coated and uncoated carbide/cermet cutting tools during turning, ULAŞ H. B., BİLGİN M., SEZER H. K. , ÖZKAN M. T. MATERIALS TESTING, cilt.60, ss.893-901, 2018

A practical application for machine design education, BÖRKLÜ H. R. , Yuksel N., ÇAVDAR K., SEZER H. K. JOURNAL OF ADVANCED MECHANICAL DESIGN SYSTEMS AND MANUFACTURING, cilt.12, 2018

ASST. PROF. MEHMET FATİH AYCAN

B.Sc. –TOBB, , Mechanical Engineering, 2008

M.Sc. - TOBB, , Mechanical Engineering, 2010

Ph.D. - Gazi University, , Mechanical Engineering, 2017

Areas of Interest: Biomechanical Tests, Powder Metallurgy, Additive Manufacturing, Implant Designs, Biomechanics, Production Technologies, Biomaterials, Mechanical Tests, Materials Science

Some Publications:

Reproducibility of Replicated Trabecular Bone Structures fromTi6Al4V ExtralowInterstitials Powder by Selective Laser Melting BalciA.,KucukaltunF.,AYCANM.F. ,USTAY.,DEMİRT. ARABIAN JOURNAL FOR SCIENCE AND ENGINEERING, 2021

Comparison of biomechanical properties of implant systems used in treatment of proximal femur fractures AYCAN M.F. JOURNALOF THE FACULTY OF ENGINEERING AND ARCHITECTURE OF GAZI UNIVERSITY, vol.34, pp.812-818, 2019

Investigation on manufacturability of bone plates used in humerus fractures by additive manufacturing method AYCAN M.F. JOURNAL OF THE FACULTY OF ENGINEERING AND ARCHITECTURE OF GAZIUNIVERSITY, vol.34, pp.2007-2016, 2019

Investigation of toggling effect on pul out performance of pedicle screws AYCANM.F., YAMAN M.E. ,USTAY., DEMİRT.,TolunayT. PROCEEDINGS OF THE INSTITUTION OF MECHANICAL ENGINEERS PARTH- JOURNAL OF ENGINEERING IN MEDICINE, vol.232,pp.395-402,2018

Pul out performance comparison of novel expandable pedicle screwwith expandable poly-etherether-ketone shel s and cement-augmented pedicle screws AYCANM.F. ,TolunayT., DEMİRT.,YAMANM.E. ,USTAY. PROCEEDINGS OF THE INSTITUTION OF MECHANICAL ENGINEERS PARTH- JOURNAL OF ENGINEERING IN MEDICINE, vol.231,pp.169-175,2017

CENTER STAFF

LECT. ANIL EMİRALİOĞLU

B.Sc. – Istanbul Technical University, Mechanical Engineering, 2013

M.Sc – Dokuz Eylul University, Mechanical Engineering, 2017

Ph.D. – Gazi University, Mechanical Engineering, 2019 - …

Areas of Interest: Powder Metallurgy, Additive Manufacturing, Friction Stir Welding, Wire Electrical Discharge Machining, Mechanical Tests, Materials Science

Some Publications:

Kasman Ş., Kahraman F., Kahraman H., Emiralioğlu A., "A Case Study for the Welding of Dissimilar EN AW 6082 and EN AW 5083 Aluminum Alloys by Friction Stir Welding". Metals 2017, 7,6

Kahraman F., Kasman Ş., Emiralioğlu A., Kahraman H., "The Effect of Pin Shape and the Ratio of Tool Rotational Speed to Welding Speed on the Mechanical Properties" ICWET'16. Gaziantep, 2016.

Kahraman F., Kasman Ş., Aydın A., Emiralioğlu A., Yousuf W., "An Experimental Study on Friction Stir Butt Welded AA7075-T651 Alloys and Their Mechanical

Properties” ICAIE’17. Elazığ, 2017.

LECT. CAN SATILMIŞ TOPRAK

B.Sc. – Kocaeli University, Mechatronics Engineering, 2014

M.Sc – Beijing Institute of Technology, Control Science and Technology, 2016

Ph.D. – Hacettepe University, Mechanical Engineering, 2018 - …

Areas of Interest**:** Machine Learning and Control Systems, Design for Additive Manufacturing, Solid Mechanics, Powder Bed Fusion Technologies

Some Publications:

Suat K., Gürkan K. Can T.; Hasan O.,” Development of a human tracking indoor mobile robot platform” Proceedings of the 16th International Conference on Mechatronics - Mechatronika, Brno, Czech Republic,2014

YUNUS YILDIZ

B.Sc. – Gazi University Electrical and Electronics Engineering, 2014

M.Sc. – Gazi University, Electrical and Electronics Engineering, 2018-2021

Ph.D. – Gazi University, Electrical and Electronics Engineering, 2022

Areas of Interest: Additive Manufacturing, Microwave Engineering, Mathematical Modeling

ÖZGE DERETARLA

B.Sc. - Gazi University Industrial Engineering, 2015

M.Sc. – Yıldırım Beyazıt University Industrial Engineering, 2021-...

Areas of Interest: Project Management, Production Planning and Control, Time Series Methods And Demand Forecasting, Additive Manufacturing, Multi Criteria Decision Making

ÜMMET ANIL YANALAK

B.Sc. - METU Metallurgical and Materials Engineering, 2019

M.Sc. - METU Metallurgical and Materials Engineering, 2019-…

Areas of Interest: Additive Manufacturing, Mechanical Testing, Material Characterization, Material Science

HÜSEYİN BERKAY EKEN

B.Sc.-METU Mechanical Engineering, 2021

M.Sc.- AYÜ Management Information System, 2022-…

Areas of Interest: Additive Manufacturing, Heat, Fluid Mechanics

EREN YAĞIZ KARACA

B.Sc. Gazi University Mechanical Engineering, 2019

M.Sc. Gazi University Mechanical Engineering, 2019-…

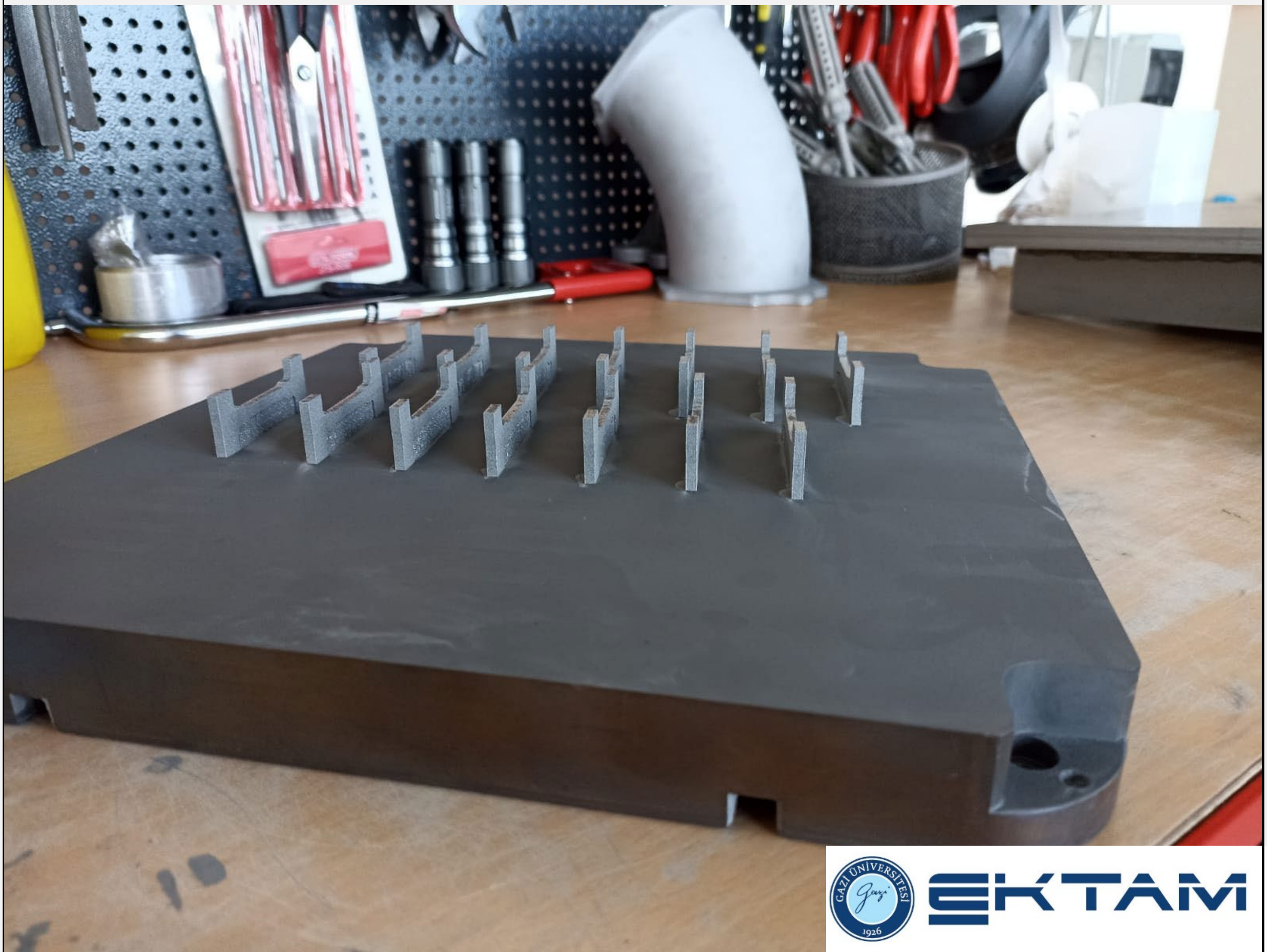
Areas of Interest: Additive Manufacturing, Mechanical Testing, Powder Bed Fusion Technologies, Machining

BEHRAM ÇİTİL

B.Sc.-Gazi University Mechanical Engineering , 2019

M.Sc.-Hacettepe University Nanotechnology and Nano medicine 2022-...

Areas of İnterest : Additive Manufacturing, Powder Bed Fusion, Nanotechnology , Nanocomposites


EKTAM

○ TEKNOHAB AREA

EKTAM BUILDING

<u>Arcam A2X EBM Machine</u>

Arcam A2X machine can produce 3D parts by melting metal powders with thanks to Electron Beam Technology which have 60 kV electric voltage. The build envelope is 250x250x380 (Width x Length x Height) mm and it can produce parts in nearly 2x10-6 bar pressure vacuum.

It processes reactive and non-reactive powders. The powders that the machine can process are as follows:

- Ti6Al4V
- Inconel 718

Concept Laser M2 Cusing SLM Machine

Concept Laser brand M2 CUSING SLM (Selective Laser Melting) additive manufacturing machine, which can produce 3D parts by using metal powders. Machine has 400W Ytterbium (Yb) fibre single-laser system. Build envelope is

250x250x280 mm (WxLxH) and machine can use Argon or Nitrogen gases during production.

Machine build parts from reactive and non-reactive powders. Below is the list of powder used:

- Stainless Steel 316L

- Ti6Al4V

- Inconel 625 and Inconel 718

- AlSi10Mg

ERMAKSAN Ena Vision 250 SLM Machine

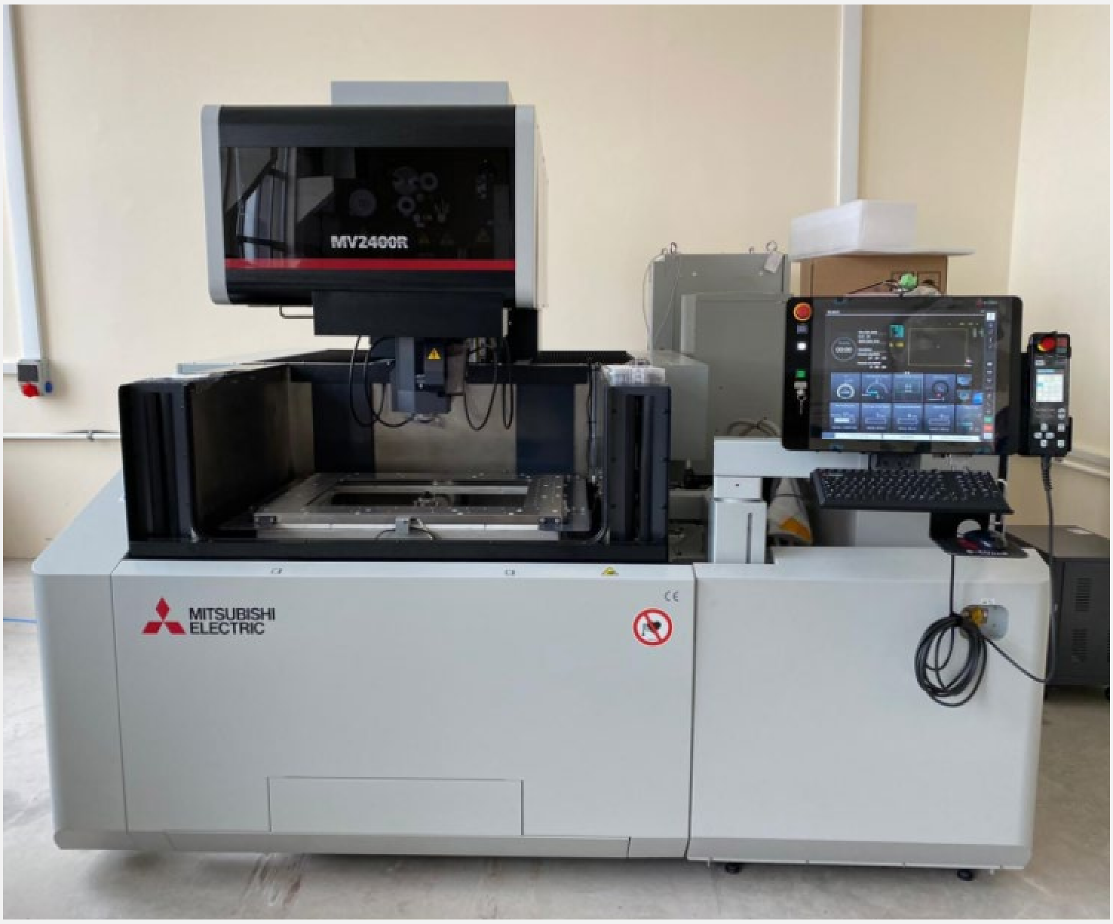
Ena Vision 250 additive manufacturing machine produced by ERMAKSAN, can produce 3D parts using fine metal powders with Selective Laser Melting technology, which has 500W fiber laser resonator system. The production volume is 250x250x300 (Width x Length x Height) mm and it can produce in Ar (Argon) and N (Nitrogen) environment.

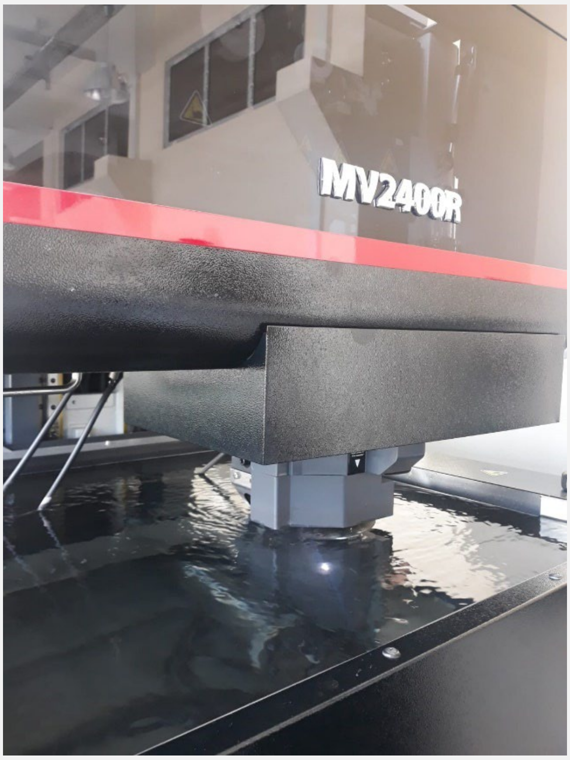
It processes reactive and non-reactive powders. The powders that the machine can process are as follows:

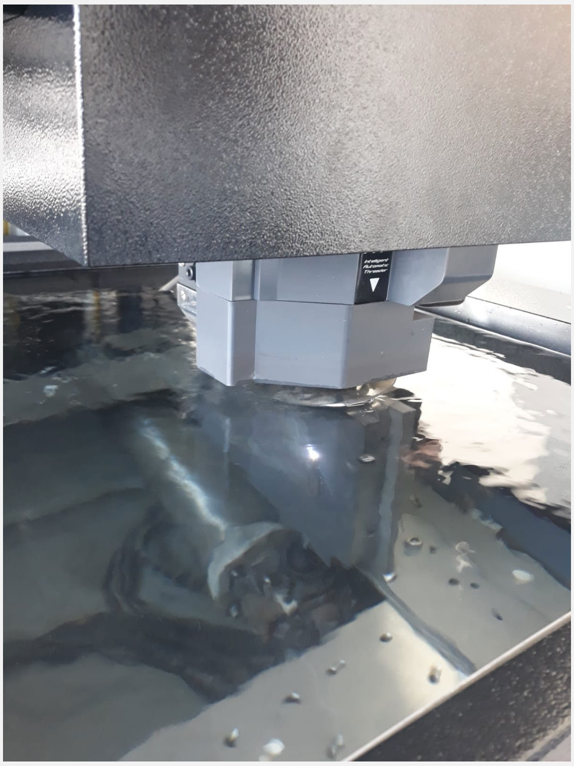
- Stainless Steel 316L
- H14 Tool Steel
- Ti6Al4V
- Inconel 625 and Inconel 718

Wire EDM Machine

MITSUBISHI MV2400R Wire EDM machine bought from TEZMAKSAN, can cut various metal parts using Wire Electro Erosion technology, which has a wire size of 0.25 mm. Machine makes precise cutting of parts made of stainless steel, titanium, aluminum alloys. Also, it is suitable for cutting the parts that produced with additive manufacturing technology from the build table.







Surface Grinding Machine

○ NEWS

<u>EKTAM Received Project Support from the European Union(EU) for the Second Time (February 13,2021)</u>

Gazi University-EKTAM received 2.39 Million Euro grant support from the COFUND Program within the scope of the Horizon 2020 Program.This program's national coordination is carried by TÜBİTAK.

"Marie Sklodowska-Curie Scholarships" under the Scientific Excellence component of the Horizon 2020 Program, Gazi University-EKTAM will be supported from the applications made within the scope of the Contribution Fund to Scholarship Programs (COFUND), has been awarded by the European Commission with 2.39 Million Euros.

The support received from the COFUND Program has been brought to Turkey with the initiatives of the Additive Manufacturing Technologies Application and Research Center (EKTAM), which was established at Gazi University and is a National Center of Excellence for Additive Manufacturing. Researches to be carried out within the scope of the project, will be carried out by EKTAM.

This program, which will take place in the field of Advanced Materials and Advanced Manufacturing Technologies, will offer an interdisciplinary, inter-sectoral and international doctoral training program of excellence in all aspects of advanced manufacturing and advanced materials, with a focus on additive manufacturing and related technologies. Scholars will receive a high-level education program that will develop their research and personal skills, offering them new career perspectives and opportunity.

Gazi University-EKTAM as the coordinator of this project (A2M2TECH), has achieved success being the first supported universities in Turkey in this program.

METU, ITU and IYTE also took part in the project as an auxiliary organization. 22 doctoral students will conduct their study in the field of Advanced Materials and Advanced Manufacturing Technology under the project and will also have an oppurtunity to corporate with TAI (TURKEY), ERMAKSAN Inc. (TURKEY), teknohab Inc. (TURKEY), Universidad Carlos III de Madrid (UC3M) (SPAIN), FIT Additive Manufacturing Group (Germany), University of Southern Denmark (SDU) (Denmark).

The list of funded projects : https://ec.europa.eu/research/mariecurieactions/cofund-recipients-2020_en

Our Research Center has been accepted to TÜBİTAK 1004 Center of Excellence Support Program (July 1, 2020)

TÜBİTAK 1004 program, which aims to transform research infrastructures of higher education institutions into the center of excellence of by collaborating with R&D / Design centers and public R&D departments, supports scientific research programs with high scientific potential which has observable goals in the priority areas determined within the scope of national targets and policies.

Within the scope of TÜBİTAK Center of Excellence Support Program (1004 Program), Gazi University applied to the "Call for High Technology Platforms" as Research Program Manager Institution (APYÖK) and it was found appropriate to support the research program titled "New Generation 3D Printer Manufacturing Technologies Platform". EKTAM has been the manager of the Research Program on behalf of Gazi University.

Platform is including 3 universities and 6 companies and those are Erzurum Technical University, Sabancı University, TÜBİTAK Marmara Research Center, ASELSAN INC., ERMAKSAN INC., ROKETSAN INC., TUSAŞ, TUSAŞ ENGINE INDUSTRIES INC. and EKTAM on behalf of Gazi University.

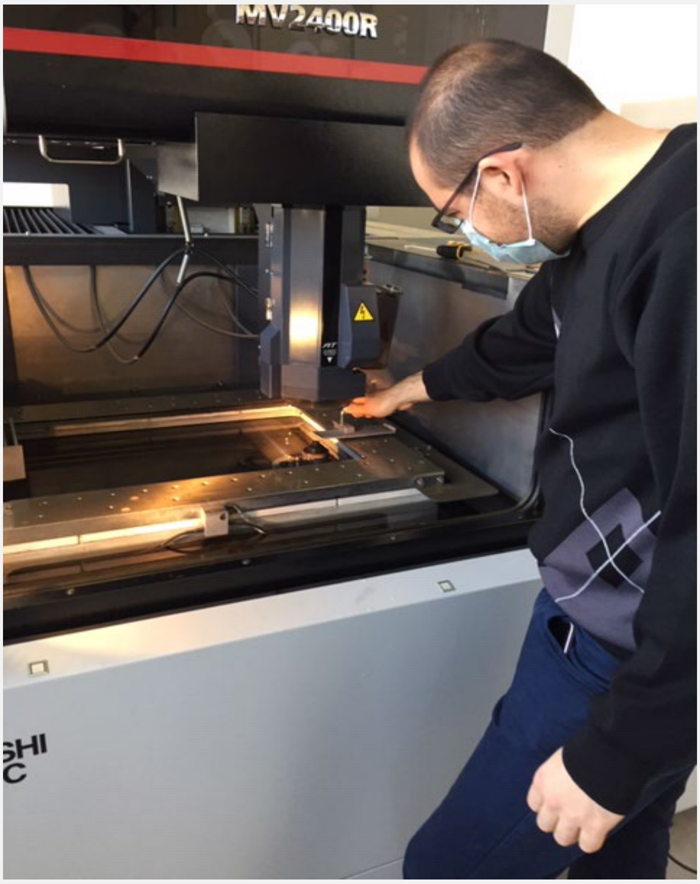
Phase 1 of the aforementioned research program has been accepted, and studies are underway to determine the projects to be carried out within the scope of Phase 2.

Digital-Can Tech Company From Taiwan Visited Our Research Center (December 11,2019)

Head of Digital-Can Tech company in Taiwan, Ping-ming Tu and Director Kuochi Chiu and Gazi Technopark General Manager Tuğrul İMER visited the techincal office of our Research Center.

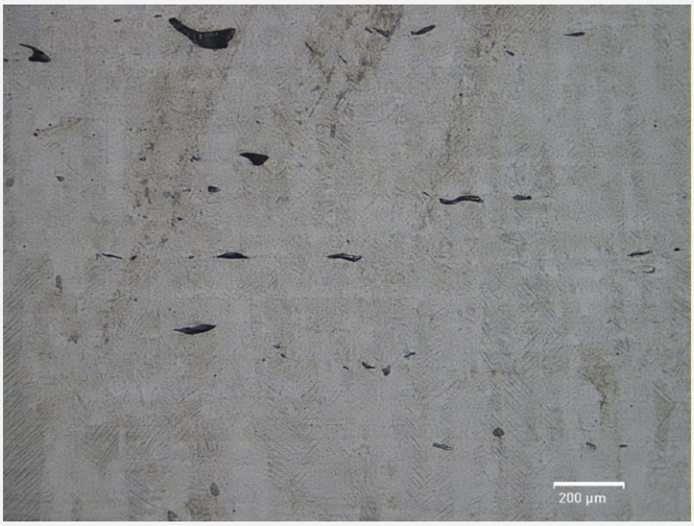
Our Center Manager Dr. Metin Uymaz SALAMCI made a presentation giving information to our guests about the projects carried out within EKTAM.

○ FROM EKTAM


MV2400R

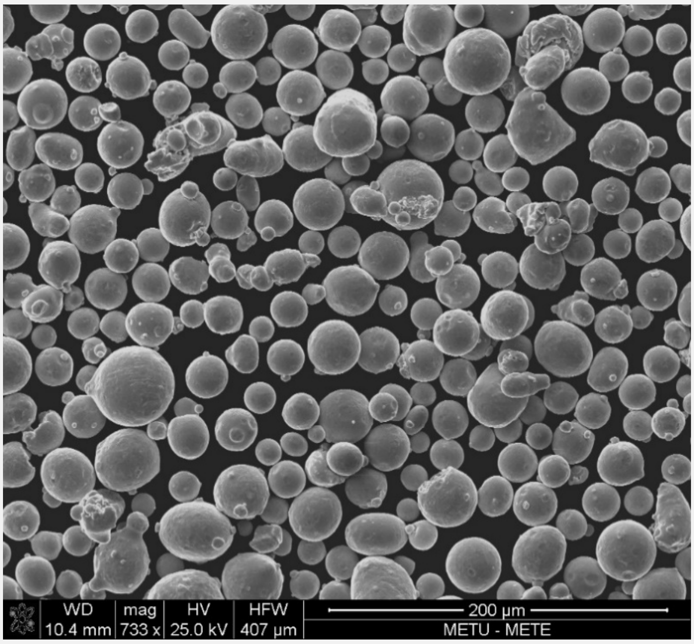

Arcam EBM
A GE Additive Company

○ RESEARCH HIGHLIGHTS



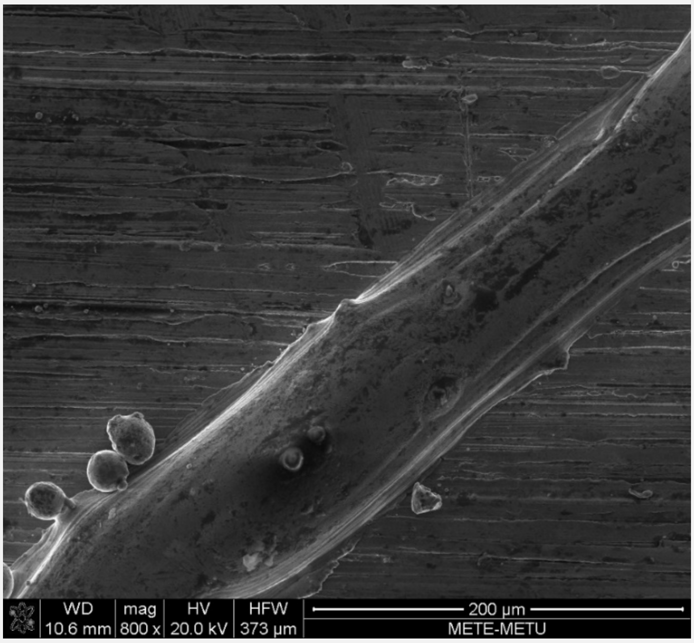
Optical Microscope Image of Selective Laser Melted Ti6Al4V

An optical microscope image showing the porosities, lack of fusion sites, columnar grains, etc. of a parameter set of selective laser melting of Ti6Al4V powder which was taken to investigate the effectiveness of the parameter set. After each experiment, this type of image is taken to characterize the material, related to its parameter set such as power, laser diameter, laser speed, etc.



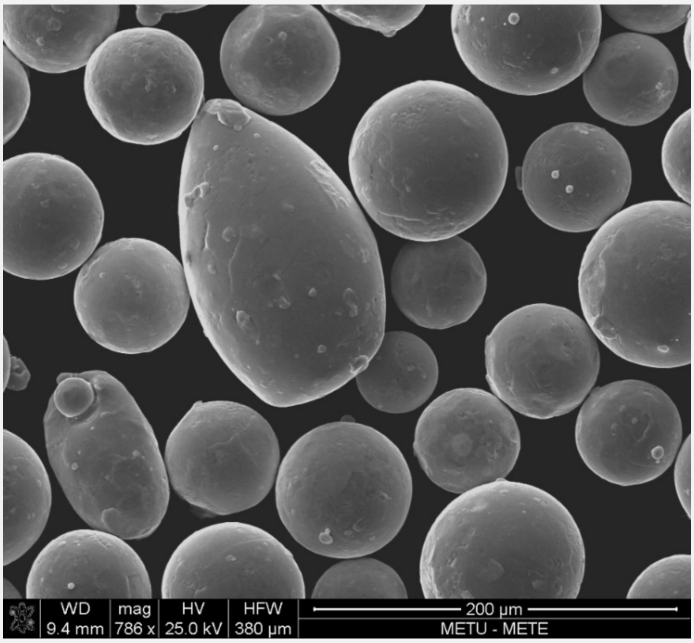
AlSi10Mg Powder SEM Image Prior to Pruduction

In powder bed additive manufacturing, most of the time the powders are re-used for a couple of productions. To understand whether the powder can be used for the next production or not, the shape of the powders and the chemical compositions are investigated prior to production using SEM.



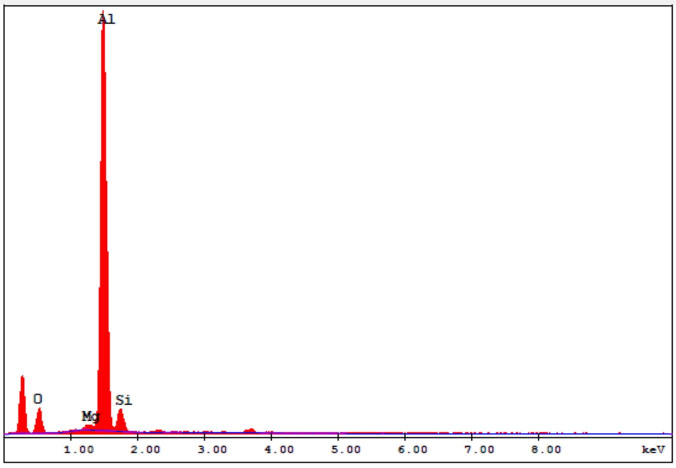
SEM Image of Single Track Selective Laser Melted S136L

Single track scanning experiments using SLM is getting more popular since it reduces time consumption and cost. In order to characterize the melt pool morphology related to process parameters, SEM is used.



SEM Image of Ti6Al4V Powder

The powders used in electron beam melting can be used several times after processed in the powder recovery system. A powder recovery system helps us to get rid of satellites, sintered powders, and powder agglomerates. To make sure that powders are ready for another production SEM images are taken.

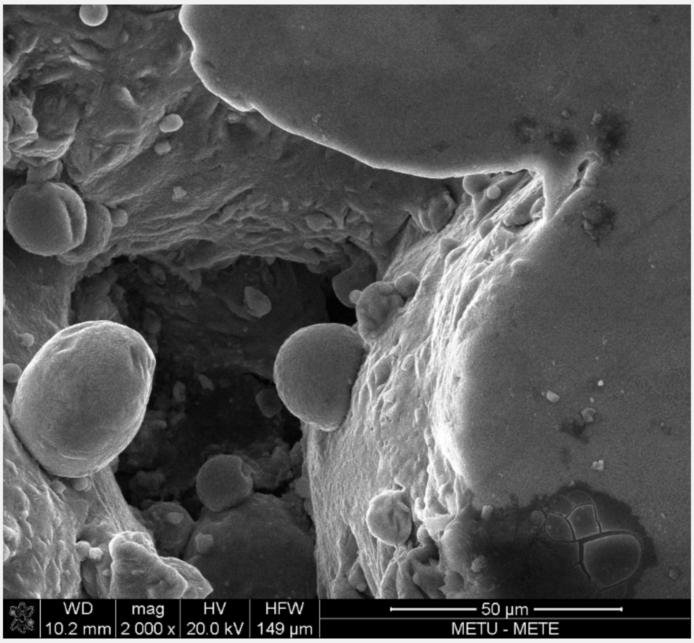


EDAX ZAF Quantification (Standardless)
Element Normalized
SEC Table : Default

Element	Wt %	At %	K-Ratio	Z	A	F
O K	18.49	27.76	0.0460	1.0525	0.2360	1.0013
MgK	0.79	0.78	0.0055	1.0124	0.6713	1.0335
AlK	68.84	61.30	0.5470	0.9832	0.8059	1.0028
SiK	11.88	10.16	0.0331	1.0124	0.2751	1.0000
Total	100.00	100.00				

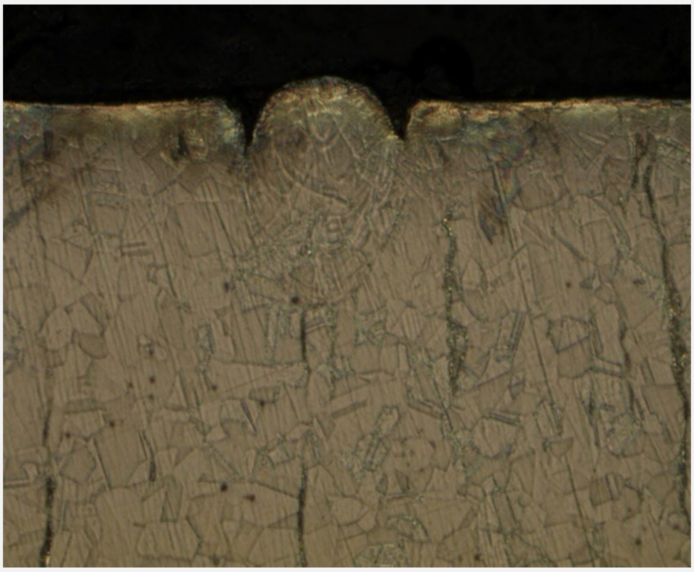
EDX data of oxidized AlSi10Mg powder

There is a production and time limit for powders to be used in next production. This table shows a powder which can not be used for further productions. Energy Dispersive X-Ray Spectroscopy is a useful method to understand the condition of powders.



SEM Image of a lack of fusion site of selective laser melted AlSi10Mg+

Too many experiments have been made to understand the effect of process parameters on density, strength, microstructure, etc. This SEM image shows an AlSi10Mg specimen produced by a low energy density. In the image, a lack of fusion site and unmelted powders can be seen.

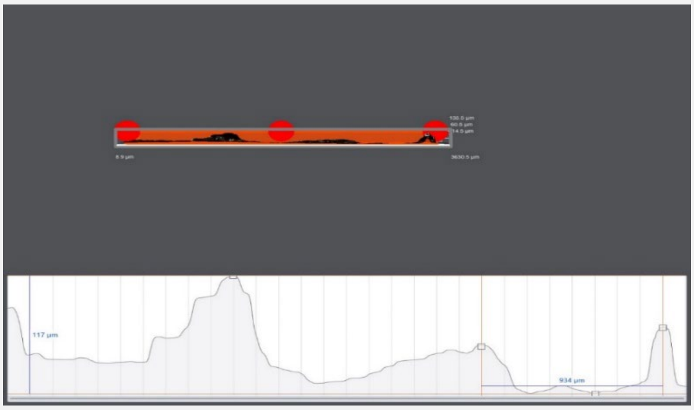


Cross Sectional Image of Selective laser melted single track s316L

This cross-sectional image of a single track production of S316L with SLM is taken in order to understand the interaction between the single bead and the build plate.

Optical Microscope Image of Electron Beam Melted Ti6Al4V

Some of the places inside the specimen are intentionally remained unscanned to understand the effect of process parameters on the melt pool depth of an electron beam melted Ti6Al4V.



Surface Characterization of a single track S316 L

Understanding the effect of parameters on surface morphology is a crucial topic. Using EDoF and 3D imaging methods the surface morphologies of AM products are made in an easy and fast way.

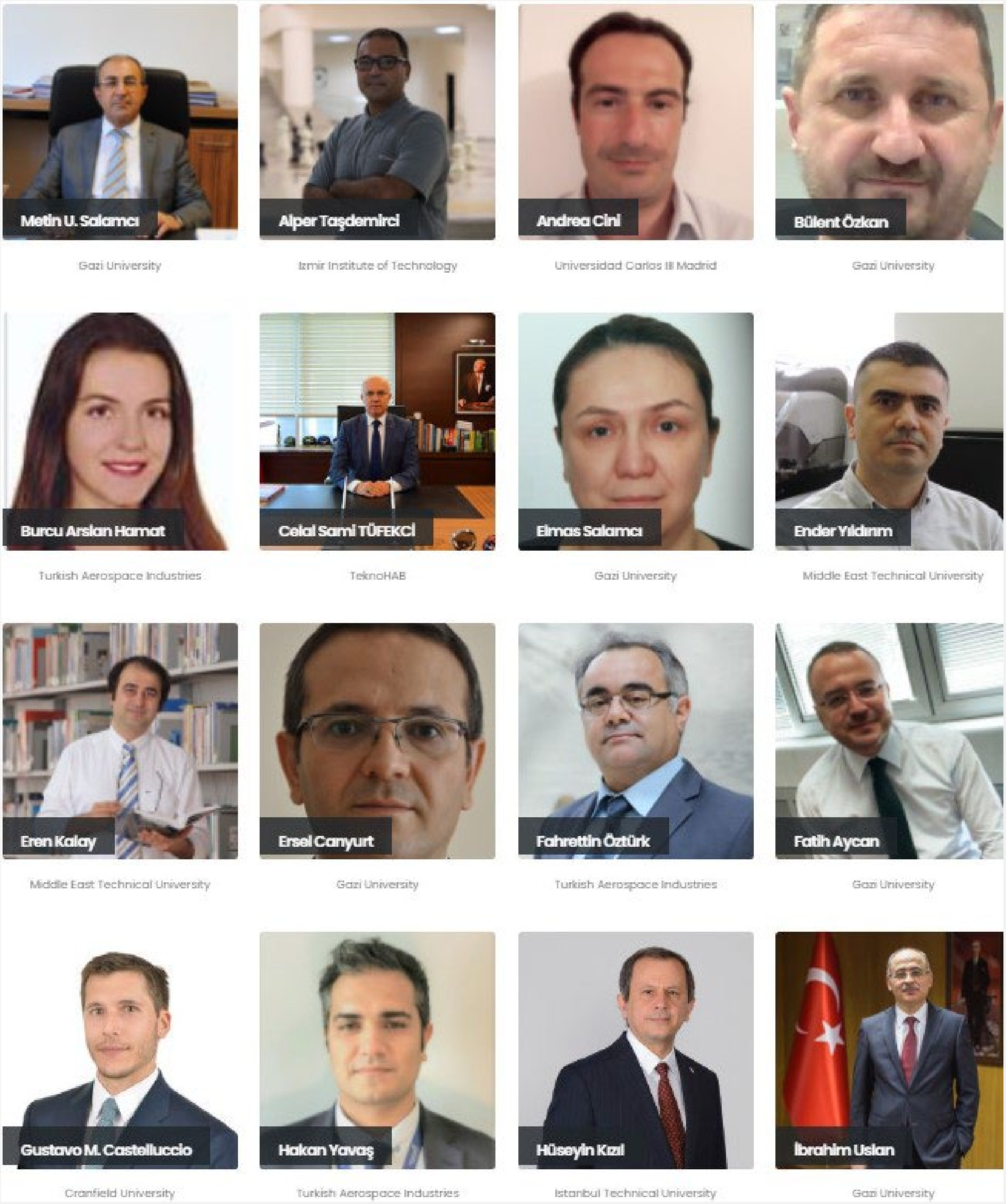
X-Y plane optical image of AlSi10Mg

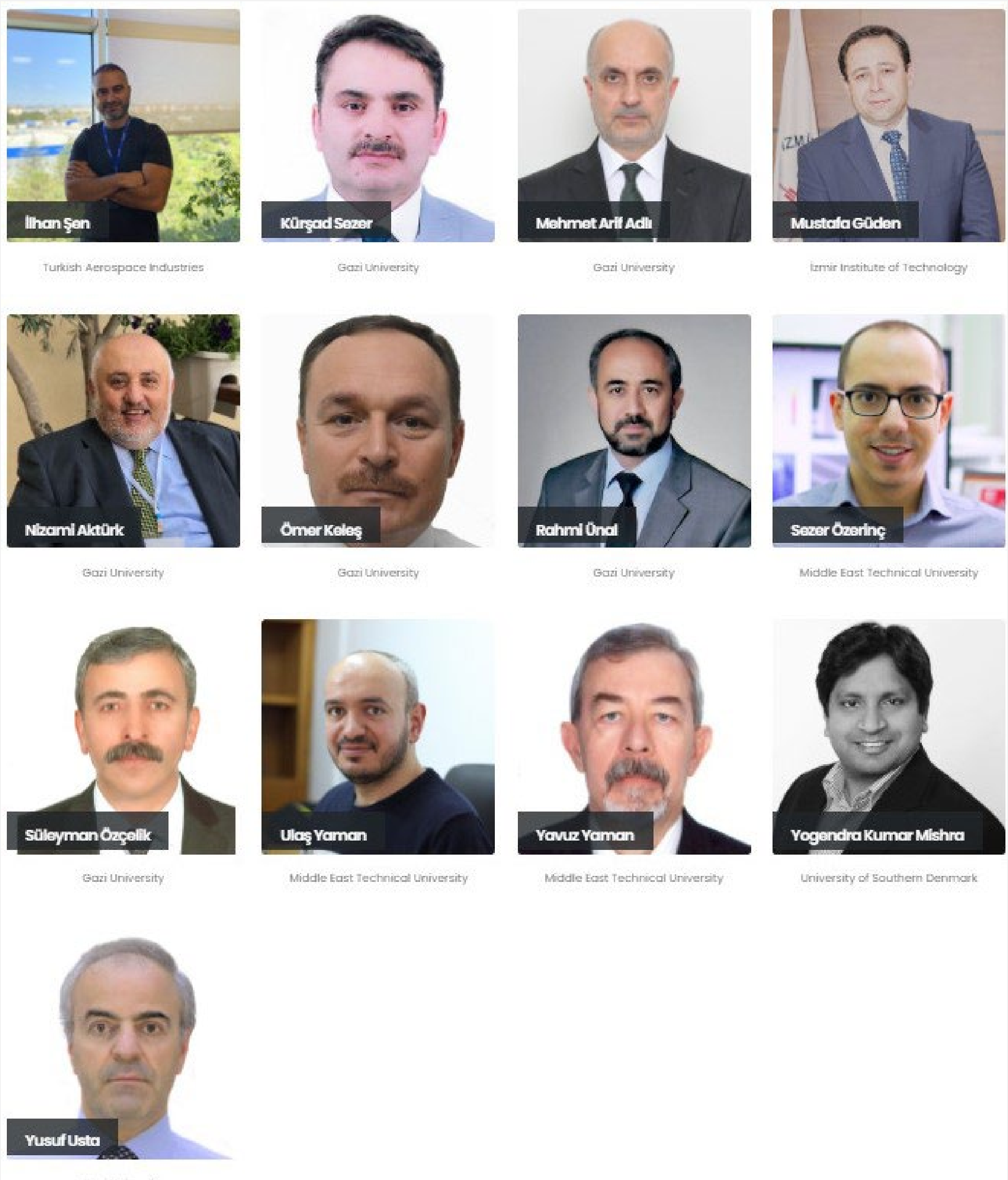
An image taken from the top side of selective laser melted AlSi10Mg specimen.

○ RESEARCH TOPICS

COFOUND

OUR TEAM

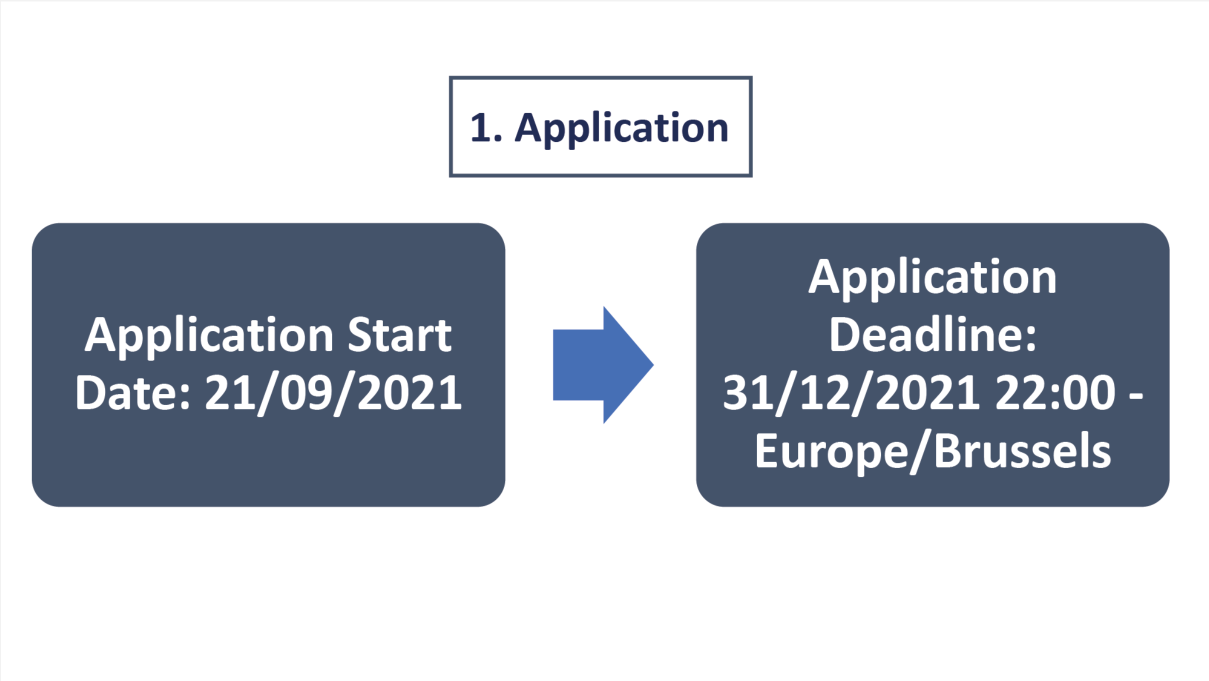




SITE LINK

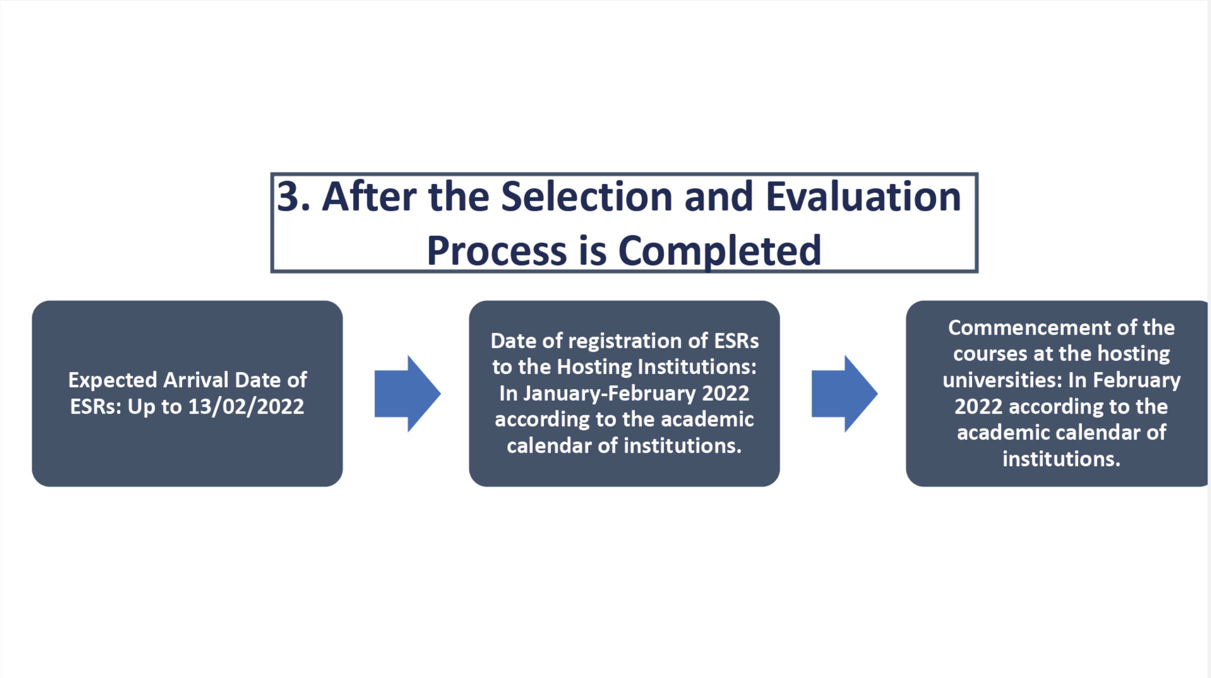
https://www.a2m2tech.org.tr

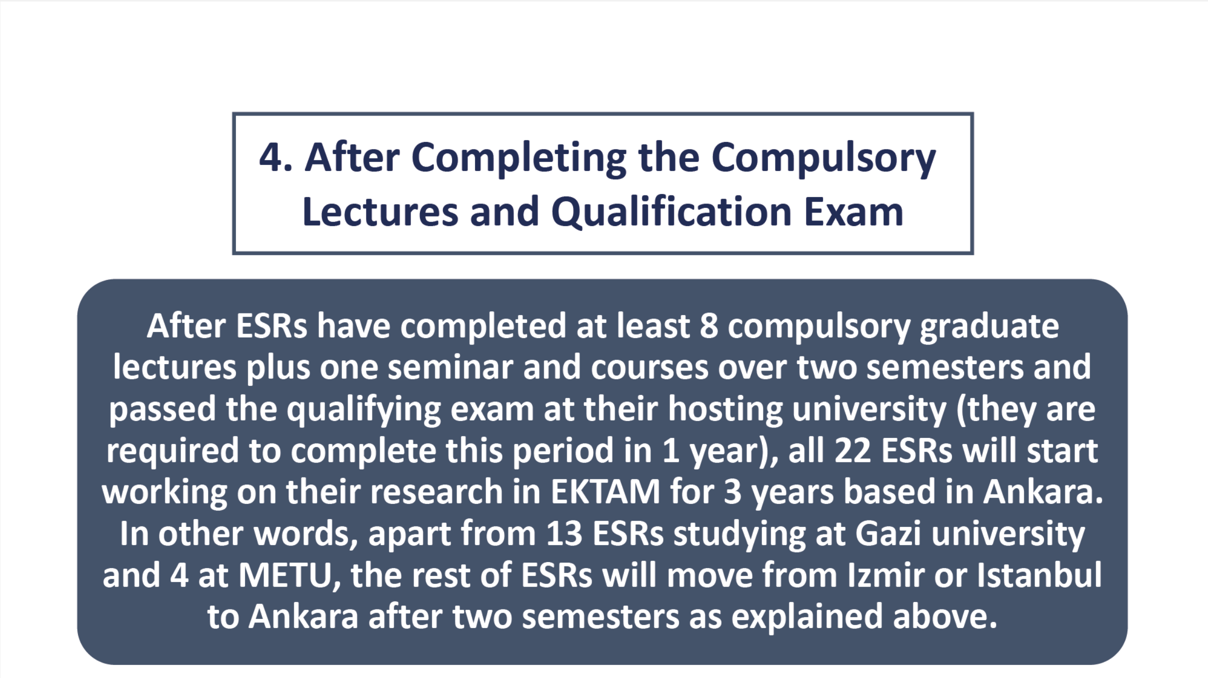
TIMELINE



1. Application
Application Start Date: 21/09/2021
Application Deadline: 31/12/2021 22:00 - Europe/Brussels

2. Evaluation Process
Eligibility Check: 01/01/2022 – 02/01/2022
SEC Process: 03/01/2022 – 07/01/2022
Interview: 10/01/2022 – 13/01/2022
Announcement of the Results: 14/01/2022
Redress Acceptation: 14/01/2022 – 20/01/2022
Announcement of Results of Redresses: 21/01/2022





DESCRIPTION AND SCOPE

We are seeking 22 Ph.D. candidates, called early-stage researchers (ESRs) to work under the project titled A2M2TECH (Doctoral Programme in Advanced Materials & Advanced Manufacturing Technologies). The aim of A2M2TECH is to deliver an interdisciplinary, intersectorial and international excellence doctoral training programme in all aspects of advanced manufacturing and advanced materials, with a major focus on additive manufacturing and related technologies. The programme brings together various strong laboratories and research centers in order to run a collaborative Ph.D. program in the fields of Advanced Materials and Advanced Manufacturing Technologies.

The programme is led by Gazi University (GU) in Turkey and coordinated through the Additive Manufacturing Technologies Application and Research Center (EKTAM), a National Center of Excellence for Additive Manufacturing. In addition to GU, there are 3 other reputable Turkish universities as Partner Organizations namely; Middle East Technical University (METU), Istanbul Technical University (ITU) and Izmir Institute of Technology (IZTECH). All universities as part of the Programme have cutting-edge technologies and have modern working environment with a view to enhancing the performance of the ESRs. Recruited ESR fellows under A2M2TECH will be primarily supervised and assessed by the

Ph.D supervisors at their host institutions, who will be responsible for the assessment of their duties with respect to the planned activities. The programme, cofounded by European Commission and The Scientific and Technological Research Council of Turkey (TÜBİTAK), provides excellent career perspectives in the area of additive manufacturing through the integration of multidisciplinary research and training in academia and industry. Recruited 22 ESRs will be provided with the opportunity to carry out research activities under secondments in several national & international host institutions with a particular focus on the inter-sectoral University-Industry collaboration. All candidates will have secondment experience in international institutions as follows: FIT Additive Manufacturing Group (GERMANY), Universidad Carlos III de Madrid (UC3M) (SPAIN), University of Southern Denmark (SDU) (DENMARK), Tusaş Aerospace Industries (TAI) (TURKEY), Ermaksan Innovative Technologies (ERMAKSAN) (TURKEY) and TeknoHAB (TURKEY). ESRs will be participating to summer school training activities each year at different organizations in different countries as part of secondments.

Through this programme, the potential ESRs will have the opportunity to grow academically and also built their career in industry at the same time. Once the potential ESRs are selected and qualified as ESRs, they will also be part of a wide range of scientific networking of the hosting top research organizations/universities and research centers.

ESRs have the chance to complete their Ph.D. in top research Universities in Turkey. In addition to that, they will also be working in organizations and techno-parks equipped with cutting edge technology in the field of advanced materials and advanced manufacturing. Moreover, the programme is designed to enhance their experience by including summer schools in and outside Turkey and also hands-on activities in real world/industry.

TOPICS

ESR 1:

Development Of Al-Mg-Sc Alloys For Aerospace Applications

Option: I

Institution: GU/EKTAM

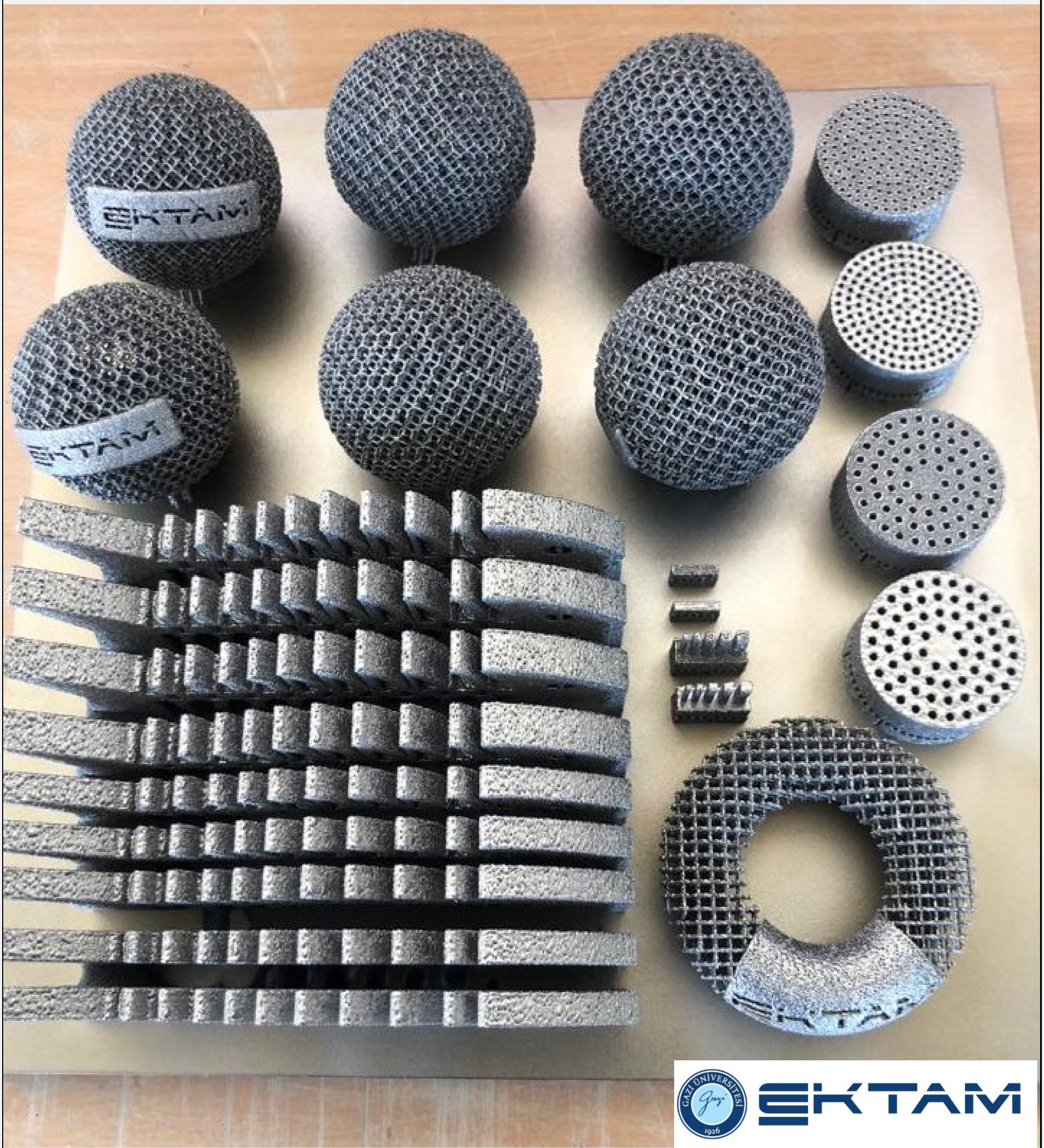
Supervisor: Rahmi Ünal, Prof., (M)
Co-Supervisor(s): -

Short description of the project

Aluminum alloys with magnesium as the major alloying element constitute a group of non-heat-treatable alloys with medium strength, high ductility, excellent corrosion resistance and weldability. Unfortunately, the strength of such Al–Mg alloys is lower than precipitation-hardening Al alloys. However, the addition of a small amount of scandium has been found to significantly improve the strength of Al–Mg alloys, owing to the presence of coherent, finely dispersed L12 Al3Sc precipitate particles that can be obtained at a high number density, thus preventing the dislocation motion. A high specific strength and excellent weldability in combination with good corrosion resistance of Al–Mg–Sc alloys make these alloys attractive for aircraft application. By using powder metallurgy (PM) route it is possible to make a high strength alloy with increased solid solubility. Earliest reports for room temperature tensile strengths of PM alloys were 548 MPa and 595 MPa for the Al-1.1Sc-6Mg and Al-1.9Sc-6Mg alloys, respectively. Al-Mg-Sc alloy was developed as Scalmalloy® for SLM processing by APWorks. Early studies report successful processing of Scalmalloy® using SLM. Relative density accomplished was well more than 99% at higher energy densities typical of other Al or Ni-based alloys. The principle strengthening mechanism observed in microscopy was supersaturation of Sc particles as well as precipitation of Al3Sc phase which pins grain boundary and hinders dislocation gliding, giving rise to superplastic material flow.

In this study, it is aimed to design a new Al-Mg-Sc alloy using the first-principle calculations using CAmbridge Sequential Total Energy Package (CASTEP) code based on density functional theory. New and unique al-Mg-Sc alloy will be developed with theoretical studies and appropriate compositions will be decided according to the desired properties. Then, these alloys will be produced experimentally, and their physical and mechanical properties will be investigated. At the end of the study, an alloy will be developed in order to produce parts that can be used in the field of aviation and space by additive manufacturing method.

Production Of Al-Mg-Sc Alloy Powders And Determination Of Process Parameters For Selective Laser Melting (SLM) Technology


EKTAM
EKTAM
GAZİ ÜNİVERSİTESİ
1926
EKTAM

Option: II

Institution: GU/EKTAM

Supervisor: Rahmi Ünal, Prof., (M)

Co-Supervisor(s): -

Short description of the project

Aluminum alloys with magnesium as the major alloying element constitute a group of non-heat-treatable alloys with medium strength, high ductility, excellent corrosion resistance and weldability. Unfortunately, the strength of such Al–Mg alloys is lower than precipitation-hardening Al alloys. However, the addition of a small amount of scandium has been found to significantly improve the strength of Al–Mg alloys, owing to the presence of coherent, finely dispersed L12 Al3Sc precipitate particles that can be obtained at a high number density, thus preventing the dislocation motion. A high specific strength and excellent weldability in combination with good corrosion resistance of Al–Mg–Sc alloys make these alloys attractive for aircraft application. By using powder metallurgy (PM) route it is possible to make a high strength alloy with increased solid solubility. Earliest reports for room temperature tensile strengths of PM alloys were 548 MPa and 595 MPa for the Al-1.1Sc-6Mg and Al-1.9Sc-6Mg alloys, respectively. Al-

Mg-Sc alloy was developed as Scalmalloy® for SLM processing by APWorks. Early studies report successful processing of Scalmalloy® using SLM. Relative density accomplished was well more than 99% at higher energy densities typical of other Al or Ni-based alloys. The principle strengthening mechanism observed in microscopy was supersaturation of Sc particles as well as precipitation of Al3Sc phase which pins grain boundary and hinders dislocation gliding, giving rise to superplastic material flow.

It is aimed to produce the powder of Al-Mg-Sc alloys for additive manufacturing technology. In this thesis study, powder production will be carried out in the gas atomization unit in the department by making Al-Mg-Sc alloy in different compositions. Appropriate metal powder production conditions will be decided by powder characterization. Then, the most suitable production parameters will be determined by making part production studies with additive manufacturing from the alloy powders produced. By examining the characterization of the parts and mechanical tests, the additive manufacturing part production conditions will be determined.

ESR 2:

Investigation Of Manufacturability Of Personalized Implant Systems With Metal-Ceramic Composite Structures By Using AM Methods

Option: I

Institution: GU/EKTAM

Supervisor: Mehmet Fatih Aycan, Ph.D., (M)

Co-Supervisor(s): İbrahim Uslan, Prof. (GU, TURKEY) (M)/ Yogendra Kumar Mishra, Prof. MSO (University of Southern Denmark, DENMARK) (M)

Short description of the project

Metal-ceramic composite structures incorporate features such as low density, high specific strength and wear resistance. Combinations with biocompatible properties are possible and can be used in the medical field. It is predicted that the use of metal-ceramic composites, which exhibit high abrasion resistance and specific strength properties close to the moving parts of the bone, in areas with high damage or low bone density, will make damage repair more successful. In addition to these advantages, it is difficult and costly to manufacture. Although there are studies on the production of these composite structures with binder jetting and SLS with the developing additive manufacturing technology, there is a lack of data on the production and implantation process in the literature. In this study, an implant that provides bone repair will be developed for the treatment of a patient with damage to the hip part of the femur bone. An implant that will support wear and loading in the patient's femoral head area will be produced by binder jetting and SLM method. The regions to be removed from the produced samples will be viewed under the microscope, and the internal structure defects and microstructures will be examined. Gap and insufficient fusion defects resulting from micro-CT imaging will be determined and modeled geometrically. Powder size and mixing ratio are among the material preparation parameters in the investigation of manufacturability with related additive manufacturing methods. The energy density for the SLM method and the binder removal and sintering conditions for binder jetting are the main parameters to be considered for production.

Investigation Of Coating Effect On Biomechanical Properties Of Additive Manufactured Humorous Fracture Fixation Plates

Option: II

Institution: GU/EKTAM

Supervisor: Mehmet Fatih Aycan, Ph.D., (M)
Co-Supervisor(s): İbrahim Uslan, Prof. (GU, TURKEY) (M)/ Yogendra Kumar Mishra, Prof. MSO (University of Southern Denmark, DENMARK) (M)

Short description of the project

Fixation of unstable bone fractures in osteoporotic patients remains a clinical challenge. The use of fracture fixation plates has become a standard treatment for proximal humeral fractures, which account for 5-6% of annual reported fractures. The locking feature of the fracture fixation plates provides a mechanical advantage by increasing the resistance of the implant. In addition to the mechanical strength advantages it provides, the alignment causes misalignment in the implant as a result of cutting the application screws due to varus collapse. Although the life of the implant is tried to be increased by using calcar screws, it is predicted that bone repair will be more successful by improving the design of the fracture fixation plates and making them specific to the patient. With the developing technology, the compatibility of additive manufacturing methods with reversible engineering has increased and implant production compatible with patient tomography can be realized. Although it is thought that the production of patient-specific fracture fixation plate will reduce problems such as varus collapse, it is striking that there is a lack of biomechanical data in the literature. In addition, studies on the effect of the change of the bone-implant connection interface behavior of the coatings to be applied to the productions made with different surface patterns or porous sections produced by additive manufacturing on the implant biomechanical properties are insufficient. In this study, special fracture fixation plates for patients with humeral fractures will be produced as porous and solid by powder bed additive manufacturing methods. Organic or inorganic coating will be applied to the plates to be produced in order to increase bone tissue development. The biomechanical behavior of the samples will be determined by measuring the displacements between the implant parts by performing compression, torsion and dynamic loading tests on the produced samples. In addition, the stresses and displacements in the structure will be examined for the aforementioned mechanical tests with the help of the finite elements and numerical analysis model to be created.

ESR 3:

Manufacturing Of A Novel Intervertebral Body Fusion Device With Different Metals Using AM Methods

Option: I

Institution: GU/EKTAM

Supervisor: Mehmet Fatih Aycan, Ph.D., (M)

Co-Supervisor(s): İbrahim Uslan, Prof. (GU, TURKEY) (M)/ Yogendra Kumar Mishra, Prof. MSO (University of Southern Denmark, DENMARK) (M)

Short description of the project

The intervertebral body fusion device is the most well-known example of porous metal implants used in spinal surgery. In this technique, in order to maintain spine alignment and disc height the entire intervertebral disc between vertebrae is removed and the cage is placed between the vertebra. If necessary, it may be placed with or without a bone graft. The cages are manufactured as a solid by conventional manufacturing methods. In comparing with solid cages, porous novel cages exhibit improved strength, lower stiffness, long term stability and more aligned with human bone properties. Porous metal cages are a good alternative for polyetheretherketone (PEEK) ones. Additive manufacturing allows to combine the biocompatibility of metal material with improved biomechanical and bone incorporative qualities for novel cages.

The cages produced with various lattice structure and metal materials as CrCo or Ti6Al4V have different fatigue, compression, compression-shear and torsion strengths as well. The effects of lattice structure for different materials on biomechanical performance of the novel metal cages will be determined. The biomechanical properties will be investigated after the productions made from CrCo and Ti6Al4V materials by selective laser melting method. After determining the optimum lattice structure for both material, the finite element models will be prepared. The models prepared will be verified by using experimental test results and the best model represented the novel design biomechanically will also be determined. Besides, completing verification of the models, the novel metal cages were compared with the solid ones produced with same materials experimentally and numerically in order to show the lattice effect.

Biomechanical Performance Of The Novel Fixation Implants Manufactured By Additive Manufacturing Methods

Option: II

Institution: GU/EKTAM

Supervisor: Mehmet Fatih Aycan, Ph.D., (M)

Co-Supervisor(s): İbrahim Uslan, Prof. (GU, TURKEY) (M)/

Yogendra Kumar Mishra, Prof. MSO (University of Southern Denmark, DENMARK) (M)

Short description of the project

The osteoporotic patients with unstable proximal humerus fractures have a major clinical challenge for achieving sufficiently good fixation. The collapse problem in bones due to low mineral bone density is one of the prominent complications may lead to screw pullout or cutout. The new design for reducing the pullout or cutout of screws complications is manufactured by additive manufacturing (AM) method. Biocompatible Co-Cr and Ti6Al4V specimens processed in laser-powder bed fusion techniques (SLM or EBM) is subjected to tensile testing, bending testing and microhardness to obtain material properties of the AM implants. The fixation properties provided by conventional locking plates with novel design concepts manufactured by AM method are compared by using both computational and experimental methods. The summary of the study is stated as follows; obtaining Micro CT/patients data, anatomy/virtual planning, reverse engineering and design modification, fabrication and post processing, characterization and finite element analysis, synthetic bones and implant construction and biomechanical testing.

ESR 4:

Compensation Of The Lattice Structure With Hybrid Unit Cell And Investigation Of Compression Properties

Option: I

Institution: GU/EKTAM

Supervisor: Yusuf Usta, Prof., (M)

Co-Supervisor(s): İbrahim Uslan, Prof. (GU, TURKEY) (M)/ Yogendra Kumar Mishra, Prof. MSO (University of Southern Denmark, DENMARK) (M)

Short description of the project

The pores of the porous structures affect the mechanical, thermal and biological properties of the material. Due to the increase in osseointegration, its effect on the amount of heat transfer and low specific gravity, porous materials have been started to be investigated in biomedical, heat exchanger and aerospace fields. Porous materials can be produced by conventional or additive manufacturing methods, and the additive manufacturing method has been found to be more controlled and reproducible. In the production of porous structures with additive manufacturing methods, the basic geometry is lattice structures and thickening and sagging occur in the production. In the study, unit cell design with hybrid geometry compensated according to production changes will be made and compression properties will be examined. Productions will be made from CoCr alloy by selective laser melting. Within the scope of manufacturability studies, benchmark production will be designed on the basis of unit cell geometry for square or cylindrical cross-section bars, spherical and elliptical surfaces, and holes with different positions and production changes will be examined. After the compensation work to be created, the change in production will be reduced. Hybrid unit cell will be designed to be use in biomedical field considering the compensation results of different geometries. The compression properties of the lattice structure produced with cubic volume for different axes will be determined and the results will be used to homogenize the structure for finite element analysis. Model verification studies will be done by comparing the results of compression tests, 3D model of the building and finite element analysis made by homogenization. The hybrid cell, whose production and strength are determined, will be applied to the empty geometry in the in-body fusion cage design and the effect of the biomedical product on compression mechanical strength will be investigated numerically and experimentally.

Investigation Of The Manufacturability Of Metal Ceramic Composite Materials From Stainless Steel And Alumina Powders By Selective Laser Melting

Option: II

Institution: GU/EKTAM

Supervisor: Yusuf Usta, Prof., (M)

Co-Supervisor(s): İbrahim Uslan, Prof. (GU, TURKEY) (M)/ Yogendra Kumar Mishra, Prof. MSO (University of Southern Denmark, DENMARK) (M)

Short description of the project

Today's additive manufacturing technology generally produces from a single material, and work on the production of parts in a single production process with various material types is a target for future research. In our study, metal-ceramic composite materials will be produced by selective laser melting method with using stainless steel and alumina powders. The parameters used in production by selective laser melting affect the energy density, and energy density has an important effect on the melting conditions and internal defect formation. In order to create sufficient melting for the productions to be made, a finite element analysis model will be created to numerically determine the energy density. Productions will be made for different energy densities (laser power, scanning speed and layer thicknesses forming these energy densities) obtained from finite element analysis. The defects of the produced samples will be examined with the help of microscope and micro-CT and the effect of parameters on production as well as energy density will be investigated. With the obtained results, the laser melting process will be developed with new production parameters and conditions. The thermal conductivity, tensile, compression and abrasion properties of composite samples with different metal and ceramic mixing ratios that can maintain their structural integrity at different temperatures will be determined.

ESR 5:

Growth Of Large Area Two-Dimensional Transition Metal Dichalcogenide Nanostructures: Fabrication Of Nanoscale Electronic And Optoelectronic Devices


GAZİ ÜNİVERSİTESİ
1926
EKTAM

Option: I

Institution: GU/ GAZI PHOTONICS

Supervisor: Süleyman Özçelik, Prof., (M)

Co-Supervisor(s): -

Short description of the project

Transition metal dichalcogenides (TMDCs; MX2, where M=Mo or W and X=S or Se) family has recently gained great attention due to its unique electrical, mechanical and optical properties. In addition, In addition, their monolayers and their heterostructures and also the form of sandwiched with wide band gap semiconductors stand out among the promising nanomaterials for the production of next-generation nanoscale optoelectronic devices, thanks to their excellent properties in light trapping and photo-sensing. Photodetectors, which have the functionality of sensing photonic signals and converting them to electric current, are an important component of electro-optical systems such as imaging, sensing and communication. TMDCs is a semiconductor material which has a layered-structure, and while the atoms within each layer in TMDCs are strongly covalently bounded, the adjacent layers are held together by weak van der Waals interaction. The Weak van der Waals interactions enable the exfoliation of TMDCs to individual atomically thin layers. Single and multilayer thin films of TMDCs have unique properties like thickness dependent band gap in visible to infrared regions, high carrier mobility, large surface-to-volume-ratio, strong spin-valley coupling, chemical stability and high mechanical flexibility. These properties make TMDCs a highly promising material in future nanoscale electronic and optoelectronic device applications such as photocatalysis, photodetectors, biosensors, gas sensors, phototransistors, field effect transistors (FETs), solar cells and light emitting diodes (LEDs).

There have been several attempts, including top-down and bottom–up methods, such as mechanical-mechanical exfoliation, hydrothermal synthesis, physical vapor deposition (PVD) and chemical vapor deposition (CVD) to produce two-dimensional (2D) TMDCs thin films. Initially, researchers intensely focused on the exfoliation method for the obtainment of monolayers of TMDCs films, which remains the most commonly used method for the growth of MoS2 films. However, it has been recently recognized that the exfoliation method is not suitable for the large scale production of 2D-TMDCs nanostructure. In this context, the synthesis of uniform large-area 2D-TMDCs layers by controlling the film thickness is necessary for the practical use of this material in electronic and optoelectronic applications in industry. CVD is one of the most promising methods to produce continuous of these structures over large areas as an alternative to exfoliation methods. However, the controllable growth of these 2D nanostructure over large areas by the CVD method remains an enormous challenge. The current understanding of the CVD growth process has significant shortcomings and, therefore, optimization studies on the growth of TMCDs films by the CVD method is currently a significant and urgently needed area of research. Proposed PhD thesis will focus on the large area growth of 2D-TMCDs (MX2, where M=Mo or W and X=S) and their heterostructures through the use of the CVD method. Structural, electrical, optical, morphological characteristics and chemical bonding structures of grown two-dimensional TMDs will be determined. In addition, the fabrication of the photodetector from the developed 2D nanomaterials will also be studied within the scope of the thesis.

ESR 6:

Robotic Laser Finishing Of Additive Components With Adaptive Control

Option: I

Institution: GU/EKTAM

Supervisor: Kürşad Sezer, Assoc. Prof., (M)

Co-Supervisor(s): Mehmet Arif Adlı, Prof. (GU, TURKEY), (M)

Short description of the project

The proposed phd project will develop a robot based adaptive laser system that can be used for post processing of additively manufactured components. Additively manufactured components can have a wide range of surface roughness characteristics depending on the power level and other relevant process parameters used with the additive process. To address the wide range of roughness in AM components, a hybrid laser source that can operate at both CW and ns will be used for polishing. The specific aim of the project is to formulate an experimentally validated numerical model that will enhance the understanding of the proposed hybrid laser polishing process. Computational fluid dynamics will be used to formulate the heating, melting, melt-pool convection and solidification. Finite element analysis will be used to model the residual stresses and distortion that occurs during the laser polishing process. A commercial multiphysics

Investigation Of Innovative Laser Beam Scanning Strategies And Beam Parameter Interactions For Net-Shape Additive Manufacturing Of AlSi10Mg Alloy Aerospace Components

Option: II

Institution: GU/EKTAM

Supervisor: Kürşad Sezer, Assoc. Prof., (M)

Co-Supervisor(s): Olcay Ersel Canyurt, Prof., (GU, TURKEY), (M)

Short description of the project

The project will deal with study of Selective laser melting (SLM) process which is one of the famous methods among additive manufacturing technologies for manufacturing complex aerospace parts. The ultimate goal of this Project is to reveal the correlation between geometrical tolerances, surface quality, metallurgical characteristics and functional performance of the components and the key process parameters including laser beam scanning strategies. Experimental and theoretical modelling methods will be used to identify and optimize windows of process parameters required to fabricate high density and net shape aerospace components using selective laser irradiation and assessment of the part quality; this will involve development of selective laser melting process on specific aerospace materials, and model to understand the fundamental mechanisms of the process to identify optimal operating conditions and followed by characterization using a number of analytical testing techniques (e.g. Optical and Scanning electron microscope, residual stress measurements via X-ray diffraction, Electron Back-Scattered Diffraction and Transmission Electron Microscopy etc.).

ESR 7:

The Investigation Of The Parameters Of Hot Isostatic Process For Additive Manufactured Metal Materials.

Option: I
Institution: GU/EKTAM
Supervisor: Olcay Ersel Canyurt, Prof., (M)
Co-Supervisor(s): Kürşad Sezer, Assoc. Prof. (GU, TURKEY) (M)

Short description of the project

After additive manufacturing, internal defects, porosity of lack of fusion, gas porosity, oxides, micro cracks) etc. play an important role in the strength of the AM products. Elimination of internal defects using post-processing methods helps to eliminate stress concentrations, crack initiation points. In this way, it is possible to obtain superior material properties with x10 – x100 times increased fatigue life, ductility and fracture toughness, reduced voids, defects, scattering, more predictive material properties, and increased safety factor. The literature reveals that hot isostatic pressure technique (HIP) is necessary to increase the strength of additive manufactured products and HIP parameters should be developed.

Hot Isostatic Pressure post-processing methods will be used to provide 100% density and improved mechanical properties and better performance. Appropriate HIP parameters needs to be determined and developed in order to obtain qualified products. In these studies, it is extremely important to optimize the selection of materials, the determination of HIP parameters for the aerospace industry. Small-grained, equiaxed microstructure can be produced in metal materials structure by hot isostatic pressure, additive manufactured materials could have a wide range of superior, isotropic mechanical properties.

The Improvement Of Mechanical Properties Of Additive Manufactured Metal Materials Using Post Process Techniques

Option: II

Institution: GU/EKTAM

Supervisor: Olcay Ersel Canyurt, Prof., (M)

Co-Supervisor(s): -

Short description of the project

The additive manufacturing method provides significant advantages for the future of sectors with limited production, especially in the aerospace and aviation sectors. It is emphasized in the literature that it is necessary to improve the microstructure criteria and mechanical properties of prototypes by applying innovative/advanced materials, design for additive manufacturing (dFAM) and post-processing techniques. Heat treatment applications that will relieve thermal stresses in the parts that will ensure the removal of pores have an important place in the post process operations.

The qualification process of the components used in the aviation industry is important for the performance of the aviation systems. Therefore, it is important to develop original production processing parameters and post-process parameters to determine innovative design methods for innovative materials that can be used by additive manufacturing technology.

ESR 8:

Additive Manufacturing Of Parts Having Varying Elemental Compositions And Properties

Option: I

Institution: GU/EKTAM

Supervisor: Ömer Keleş, Prof., (M)

Co-Supervisor(s): -

Short description of the project

Additive manufacturing becomes critically important for designing and producing selective parts. In practical applications, some parts are expected to have varying properties, such as hardness and wear resistance, to fulfil the required tasks. Some of these parts include bearings, drill bits, cutting tools, and similar. Surface of these parts are expected to have higher hardness and wear resistance with higher thermal conductivity than the bulk properties. This is because of the fact that mechanical friction creates high temperature and high wearing on the surfaces because of the nature of the mechanical loads. Hence, creating multi-functional hard surfaces resisting wear and dissipating heat becomes demanding. Moreover, 3D printing of such parts with varying properties is challenging because of thermal and mechanical integrity of selected powders having different properties. Blending of carbide powders with powder used for printing of the parts may appear to be one of the solutions towards creating such parts with multi-functional properties. In the proposed thesis study, 3D printing of multi-functional parts is to be investigated while incorporating blend of various metallic and carbide powders. Thermal modeling of the heat transfer (including melting) during 3D printing will be considered incorporating the commercial software such as Comsol, ANSYS or Abacus. Thermal stress fields formed in the parts are also modelled to assess the residual stresses. The characterization tests including metallurgical and morphological changes, hardness, mechanical properties (fracture toughness, tensile, fatigue, and creep) are to be conducted for the parts produced. The optimal printing conditions are, then, identified.

ESR 9:

Fatigue Performance Of Additively Manufactured Metamaterials Under Random Vibration Conditions: The Effects Of Topology And Material

Option: I

Institution: GU/EKTAM

Supervisor: Nizami Aktürk, Prof., (M)

Co-Supervisor(s): Metin U. Salamci, Prof. (GU, TURKEY) (M)/ Celal Sami Tüfekçi, Ph.D. (TeknoHAB, TURKEY) (M)

Short description of the project

Depending on the physical property of interest, metamaterials are called optical metamaterials, mechanical metamaterials, or acoustic metamaterials. Mechanical metamaterials have attracted great interest due to their ability to attain material properties outside the bounds of those found in natural materials. Many promising mechanical metamaterials have been designed, fabricated, and tested, however, these metamaterials have not been subjected to the rigorous requirements needed to certify their use in demanding industrial applications that require multifunctional behavior. They are more commonly used in the space, the transportation, the energy and the nuclear industry. This metamaterial offers an agile and economical solution for the realization of next generation components.

Additive manufacturing techniques enable fabrication of many different machine parts with outstanding combinations of topological, mechanical, and mass properties. It is not well understood to what extent the metamaterial will resist the fatigue under harsh conditions such as when it is excited under random conditions. Additive manufacturing of titanium components holds promise to deliver benefits such as reduced cost, weight and carbon emissions during both manufacture and use. However, it must be shown that the mechanical performance of parts produced by additive manufacturing can meet design requirements that are typically based on wrought material performance properties. Of particular concern for safety critical structures are the fatigue properties of parts produced by Additive Manufacturing. Researchers point out that the fatigue properties of specimens produced by the laser melting additive manufacturing process is significantly lower compared to wrought material. This reduction in fatigue performance was attributed to a variety of issues, such as microstructure, porosity, surface finish and residual stress.

Residual stresses are an inescapable consequence of manufacturing and fabrication processes, with magnitudes that are often a high proportion of the yield or proof strength.

Despite this, their incorporation into life prediction is primarily handled through sweeping assumptions or conservative application of statistics. This can lead to highly conservative fatigue design methodologies or unforeseen failures under dynamic loading. The pull from the desire for higher levels of materials performance, coupled with the push of more sophisticated techniques for residual stress measurement, favors a reassessment of the accuracy of assumptions made about residual stresses and their modification during fatigue cycling.

This research therefore aimed to determine fatigue behavior of the additively manufactured metamaterials under real random input. The effects of material type, manufacturing imperfections, and topological design will be searched for fatigue life.

Vibro-Acoustic Characteristics Of Metamaterials Under Real Working Conditions: The Effects Of Topology And Material

Option: II

Institution: GU/EKTAM

Supervisor: Nizami Aktürk, Prof., (M)

Co-Supervisor(s): Metin U. Salamci, Prof. (GU, TURKEY) (M)/ Celal Sami Tüfekçi, Ph.D. (TeknoHAB, TURKEY) (M)

Short description of the project

Depending on the physical property of interest, metamaterials are called optical metamaterials, mechanical metamaterials, or vibroacoustic metamaterials. Vibroacoustic metamaterials have attracted great interest due their ability to attain material properties outside the bounds of those found in natural materials. Many promising vibroacoustic metamaterials have been designed, fabricated, and tested, however, these metamaterials have not been subjected to the rigorous requirements needed to certify their use in demanding industrial applications that require multifunctional behavior. They are more commonly used in the space, the transportation, the energy and the nuclear industry. This metamaterial offers an agile and economical solution for the realization of next generation components.

Vibroacoustic metamaterials are a potential compact and lightweight solution for noise and vibration reduction. By including damping in the vibro-acoustic modelling of these metamaterials, insight is gained in the effects of damping and more accurate vibroacoustic performance predictions may be obtained. Metamaterials are periodically structured materials effecting physical quantities that can be described by a wave. The periodic structure of the material leads to non-natural properties, like a negative effective mass.

Actual research topics are the computation of acoustic metamaterials made using additive manufacturing techniques. The influence of the propagation of the sound wave in the structure itself is also of interest.

Additive manufacturing techniques enable fabrication of many different machine parts with outstanding combinations of topological, mechanical, and mass properties. Nowadays more research into vibroacoustic of metamaterials are carried out due to urgent need particularly in space industry.

This research therefore aimed to determine vibroacoustic behaviour of the additively manufactured metamaterials under real input. The effects of material type, manufacturing imperfections, and topological design will be searched for vibroacoustic as well.

ESR 10:

Robot Assisted Post Processing In Additive Manufacturing

Option: I

Institution: GU/EKTAM

Supervisor: Mehmet Arif Adlı, Prof., (M)

Co-Supervisor(s): Bulent Özkan, Assoc. Prof., (GU, TURKEY), (M)

Short description of the project

Robots are versatile and skillful machines which offer flexibility in complex manufacturing processes that are otherwise difficult to perform. When cooperating together, robots can provide much more maneuverability to manipulate tools and perform task on complex geometries. This aspect has recently speeded up the efforts to use the robots to expand the capabilities of additive manufacturing (AM) processes. Robots have already been used in several AM processes, such as conformal deposition, large-scale AM and multi-directional fabrication, etc. Post processing of complex parts is another possible functional capability of AM processes that can be expanded by using robots.

Multiple cooperating robots can coordinate to perform post processing operations of the parts manufactured via AM which have extremely complex geometries obtained by topology optimization.

In this study, we propose a novel control algorithm that allows two robot arms to cooperate successfully to perform post processing of parts with extremely complex geometries. In the proposed control algorithm, while one of the robot arms manipulate the part the other simultaneously performs the post processing operation. This allows a very high degree of flexibility and maneuverability which is otherwise extremely difficult to achieve with the existing conventional methods. The hybrid position and force control algorithm enhanced with the impedance control will incorporate the complex motion planning and the interaction forces between the robot arms and the part being processed.

ESR 11:

Advancing Metal Additive Manufacturing Post-Processing Techniques: Development Of Novel Heat-Treatment And Surface Finishing Methodologies And Procedures To Minimize Residual Stresses

Option: I

Institution: GU/EKTAM

Supervisor: Elmas Salamcı, Assoc. Prof., (F)

Co-Supervisor(s): Hakan Yavaş, Ph.D. (TUSAS, Turkey), (M)/ Fahrettin Öztürk, Prof. (TUSAS, TURKEY) (M)/ Burcu Arslan Hamat, Ph.D. (TUSAS, TURKEY) (F)

Short description of the project

Brief Information About the Department and Research Center(s)

With 37.000 students (1.500 foreign), 11 faculties, 5 graduate schools, and 3 vocational colleges, Gazi University (GU), established in 1926 in Ankara, is top-10 University in Turkey mainly focusing on science and technology. Having strong laboratories and research centers in the fields of "life sciences", "photonics" and "additive manufacturing", Gazi University has been classified as a "research university" to foster "research and development" activities together with industry and other university/institutions. It has played an important role in the development of Turkey with its academic and technological achievement and proved its success in education both nationally and internationally, thus providing an excellent environment for the development of the doctoral programme. Established by Gazi University in 2017, the Additive Manufacturing Technologies Application and Research Center (EKTAM) is the National Center of Excellence for Additive Manufacturing to accelerate the deployment of this technology and develop novel materials, products and services in the advanced materials, advanced and additive manufacturing value-chains regarding process design, modelling & simulation, materials, post-processing, product, certification and end-life, with the aim of developing a set of technologies, materials and processes that could be applied to the AM field.

Integration Of Computational Material Methods Into Design For Additive Manufacturing (DfAM): Analysis Of Phase Transformations In Powder Bed Laser Fusion Systems

Option: II
Institution: GU/EKTAM
Supervisor: Elmas Salamcı, Assoc. Prof., (F)
Co-Supervisor(s): Yogendra Kumar Mishra, Prof. MSO (University of Southern Denmark, DENMARK) (M)/ Hakan Yavaş, Ph.D. (TUSAS, Turkey) (M)/ Burcu Arslan Hamat, Ph.D. (TUSAS, TURKEY) (F)

Short description of the project

Test

ESR 12:

Modeling The Impact Of Processing-Structure-Property Uncertainty On Digital Certification For Additive Manufacturing In Aerospace

Option: I

Institution: GU/EKTAM

Supervisor: Metin U. Salamci, Prof., (M)

Co-Supervisor(s): Hakan Yavaş, Ph.D. (TUSAS, Turkey) (M)/ Gustavo M. Castelluccio, Ph.D. (Cranfield University, UK) (M)/ Andrea Cini, Ph.D. (Universidad Carlos III Madrid, SPAIN) (M)

Short description of the project

Advances in metallic 3D printing will reshape engineering disciplines in the next decade by enabling cheaper and more flexible designs. Hence, this PhD opportunity will nurture innovators that advanced certification-friendly 3D printing through computational optimization.

Proposed research:

Certification procedures of critical components require survival under realistic in-service conditions that can couple various degradation mechanisms. These assessments are expensive and time-consuming for 3D printing materials given their large number of defects. This work will focus on assessing early fatigue damage by characterising manufacturing-induced defects to recreate realistic synthetic finite element models. We will rank the severity of defects as well as the detrimental role of defect aggregation and coalescence by evaluating the role of microplasticity on crack growth variability.

The research will advance the understanding of failure prognosis in 3D printing of metallic materials by ranking defects associated to manufacturing procedures. The uncertainties related to defect attributes and crack detection will be added to the probabilistic nature of a fatigue crack nucleation model and taking into account their intrinsic variability. The ultimate objective is to develop a life prognosis approach that couples the variability associated to both inspection and material uncertainties. This approach will be unique in enabling a robust probabilistic assessment that accelerates the certification of manufacturing procedures through computational iteration.

Chaotic Behavior Analysis In Rapid Liquidation-Solidification Mechanisms In Additive Manufacturing; Effects Of Process Parameters On Marangoni Flows

Option: II

Institution: GU/EKTAM

Supervisor: Metin U. Salamci, Prof., (M)

Co-Supervisor(s): Yogendra Kumar Mishra, Prof. MSO (University of Southern Denmark, DENMARK) (M)

Short description of the project

Additive Manufacturing (AM) methodologies are preferred to generate complex geometries whilst ensuring final part requirements with relatively decreased processing time. The success of the AM process is dominated by many process parameters among which the exerted energy, speed of the process, and the layer thickness are considered to be mathematically changeable during the process so that the required final product is obtained. These parameters, together with the material properties such as density, thermal capacity, phase transformation temperatures, cooling rates etc., determine the so-called “melt pool dynamics”. The melt pool formation in an AM methodology is a complex phenomenon that is studied carefully to understand several defects such as balling, cracks, pores, or low layer uniformity that are counterproductive to efficiency and part quality.

Proposed research:

This research involves investigation of melt pool dynamics in an AM process due to different process parameters. The AM process is regarded as a “rapid liquidation-rapid solidification mechanism” resulting in many nonlinear behaviors among which “Marangoni Flow” has a Chaotic nature. By using the heat, continuity, momentum, Cahn-Hilliard - etc. equations simultaneously, the effects of process parameters on the Marangoni Flow will be explored. Relevant software will be utilized to solve the multi physics equations and to simulate the process. The simulation results will be validated by experimental studies to be performed in the Additive Manufacturing Technologies Application and Research Center. Chaotic behavior analysis will be carried out for a set of process parameters in a high fidelity simulation environment and the resulting morphology will be correlated with the experimental validations.

ESR 13:

Robust Controller Design For Effective Process Parameters In Selective Laser Melting Of Metallic Materials

Option: I

Institution: GU/EKTAM

Supervisor: Metin U. Salamci, Prof., (M)

Co-Supervisor(s):) Celal Sami Tüfekçi, Ph.D. (TeknoHAB, TURKEY) (M)

Short description of the project

Final part properties in an Additive Manufacturing (AM) process are determined by the so-called "process parameters", some of which are input variables to the AM process such as power, operation speed, layer thickness, pre-heating value, post-heating value, etc. The applied set of these input variables result in output variables among which operation temperature is the most effective one on the quality of the AM process. The input and output relationship in the AM process suggests a process controller design structure to be viable for a desirable set of process parameters.

Proposed research:

This research study will focus on robust controller design and implementation in an AM process of metallic materials by the so-called Selective Laser Melting (SLM). The study starts with mathematical modelling of the AM process, by considering energy—material interactions. For this purpose, related mathematical equations, such as the heat, continuity, momentum, Cahn-Hilliard - etc. equations will be solved simultaneously. Then the relationship between input variables (laser power, scanning speed, layer thickness, laser spot diameter, etc.) and output variables (melting/evaporation temperatures, melt pool dimensions) will be extracted. Based on the deterministic model of the AM process, robust controllers (sliding mode controller, model reference adaptive control, etc) will be designed and will be simulated. The experimental study will also be conducted for a set of certain metalic materials in an SLM machine.

The research will propose a novel process control algorithm to effectively control the SLM machine in the AM process of metallic materials. The method will be unique in enabling a robust controller for the process parameters.

Design And Test Rules For Vibration Analysis Of Additively Manufactured Samples: A Certification Guideline For Industrial Applications

Option: II

Institution: GU/EKTAM

Supervisor: Metin U. Salamci, Prof., (M)

Co-Supervisor(s): Nizami Aktürk, Prof., (GU, TURKEY) (M)/ Celal Sami Tüfekçi, Ph.D. (TeknoHAB, TURKEY) (M)/ Gustavo M. Castelluccio, Ph.D. (Cranfield University, UK) (M)

Short description of the project

Additive Manufacturing (AM) methodologies are preferred to generate complex geometries whilst ensuring final part requirements with relatively decreased processing time. The success of the AM process is dominated by many process parameters among which the exerted energy, speed of the process, and the layer thickness are considered to be mathematically changeable during the process so that the required final product is obtained. These parameters, together with the material properties such as density, thermal capacity, phase transformation temperatures, cooling rates etc., determine the so-called "melt pool dynamics". The melt pool formation in an AM methodology is a complex phenomenon that is studied carefully to understand several defects and properties. Because of the defects, the vibration analysis of additively manufactured parts is also affected by the process parameters and the design itself.

Proposed research:

This PhD study proposes a certification-friendly AM process through computational optimization, focusing on vibration analysis. Certification procedures of critical components require survival under realistic in-service conditions that can couple various degradation mechanisms. These assessments are expensive and time-consuming for AM process of materials given their large number of defects and other parameters.

This work will focus on assessing vibration analysis of parts produced in an AM process. The effects of the defects (as a result of selected process parameters) on the vibration characteristics will be investigated and process parameter windows will be selected for a certifiable part. The certification guidelines for an industrial application will be sketched to integrate the process parameters and designs to the vibration test rules of additively manufactured parts.

ESR 14:

High Entropy Materials For The Additive Manufacturing Of Aerospace Materials

Option: I

Institution: METU

Supervisor: Eren Kalay, Prof., (M)

Co-Supervisor(s): Hakan Yavaş, Ph.D. (TUSAS, Turkey) (M)

Short description of the project

Modern aerospace and defense applications call for alloys with a stringent combination of properties, such as high strength, low density, and excellent environmental stability. Many well-known traditional metallic alloys, such as steel, age-hardened Al alloys, and shape-memory alloys, rarely have more than three principal alloying elements. However, the emergence of a new class of alloys – the so-called "high entropy alloys" (HEA) has sparked significant scientific interest in materials with multiple principal components. These alloys contain five or more metallic elements with an atomic percentage between 5-35%. The high configurational entropy favors the formation


GAZİ ÜNİVERSİTESİ
1926
EKTAM

of a multi-component solid solution instead of a complex intermetallic compound. HEAs have shown tremendous potential due to attractive properties like high strength and thermal stability. Much of these properties are derived from accessing kinetically stabilized phases and solid solutions.

In that sense, the thesis study will focus on the development of novel lightweight HEA to be used as a structural candidate material in space applications (i.e., micro-satellites). The development of HEAs will start with computational methods, including phase stability analysis by CALPHAD method and atomistic approach simulation by ab-initio technique to determine the ideal crystal structure of the determined composition. After that, the alloys found by computational results will be produced by arc and induction melting methods to obtain the actual test data, including mechanical properties. The powder production of successful alloys will be studied by the gas atomization process to obtain a feedstock suitable for the selective laser melting process (SLM). After accomplished its powder characterizations and tests, a predefined geometry will be produced by the SLM process as a rival to the real conventional part.

ESR 15:

Additive Manufacturing Of New Generation Materials And Structures For Automotive Applications

Option: I

Institution: METU

Supervisor: Sezer Özerinç, Assoc. Prof., (M)

Co-Supervisor(s): Ender Yıldırım, Assoc. Prof., (METU, TURKEY), (M)

Short description of the project

Additive manufacturing of structural parts has enabled new capabilities for the efficient design of a wide range of automotive parts. This thesis will explore the capabilities of polymer and metal 3D printing technologies such as fused deposition modeling (FDM), continuous liquid interface production (CLIP) and electron beam melting (EBM) towards this route. The focus will be on the development of structural parts such as shock absorbers and interior body panels. The thesis will combine various approaches such as cellular structures, multi-material printing, gradient structures and topological optimization towards the development of high specific strength and impact resistant parts. The model structures to be developed will be analyzed in terms of geometrical accuracy, microstructure and mechanical behavior. The PhD student will have a secondment at the R&D Headquarters of Ford located in Gebze, İstanbul, and will get a chance to investigate the feasibility of these emerging approaches for automotive industry.

ESR 16:

A Genetic Topology Optimization Algorithm For Hybrid-Additive Manufacturing

Option: I
Institution: METU
Supervisor: Ulaş Yaman, Assoc. Prof., (M)
Co-Supervisor(s): Sezer Özerinç, Assoc. Prof., (M)

Short description of the project

Topology optimization has been studied for decades to obtain better mechanical properties with less material utilization while designing the parts. Despite the high performance of these approaches, it wasn't possible to manufacture the resulting optimized parts due to the complex topologies they had. After the invention of additive manufacturing methodologies, it became easier to fabricate these intricate geometries with organic forms and small features. In the last decade, researchers did focus on different aspects (minimization of support structures, surface roughness, fabrication time, etc.) of topology optimization of parts to be fabricated with additive manufacturing methods. Among the optimization methods, evolutionary (genetic) algorithms have gained attention due to their robustness. In this study, we propose a novel genetic algorithm tailored for hybrid-additive manufacturing technologies, where complexity is not a concern. The fitness function used to compare the performances of the chromosomes is based on finite element analysis and the manufacturability of the corresponding topology. We obtain the initial population according to the volume constraint, boundary conditions and the applied loads on the original part. After the evaluation of the current generation, we will perform selection, crossover and mutation operations to obtain the next generations. In the selection operation, we will simply remove the worst half of the population and continue with the best half. Regarding the crossover, we will utilize the best half of the current generation to obtain the children for the new generation. In the mutation, we will be introducing major topology changes, such as introducing a connecting edge between the current ones, on the current generation. The details of the method will be studied in this thesis. We will compare the proposed method with the other evolutionary topology optimization methods in the literature through commonly utilized examples (cantilever beam, simply supported beam, etc.). Furthermore, we will manufacture sample parts on a polymer based hybrid-additive manufacturing system and test them under certain conditions.

Polymer Rapid Tooling For Fabrication Of Microfluidic Lab On A Chip Devices

Option: II
Institution: METU
Supervisor: Ender Yıldırım, Assoc. Prof., (M)
Co-Supervisor(s): Ulaş Yaman, Assoc. Prof., (M)

Short description of the project

Thermoplastic microfluidic lab-on-a-chip devices can be prototyped by various techniques such as micro milling and laser engraving. However, once the design is analytically validated, a clinical testing is mostly required before the design is introduced as a commercial point-of-care or in vitro diagnostic product. At this stage, a medium or high-volume production of the design is required. Typically, hot embossing (for medium volume) and injection molding (for high volume) are utilized for this purpose. However, in the development stage, the designs mostly do not meet the requirements and medium/high-volume production methods, as they are prototyped in the development stage by different means such as micro milling or laser engraving. This gap renders a scalability issue and impedes the commercialization of microfluidic lab-on-a-chip devices. To solve this problem, a scalable manufacturing scheme must be adopted starting from the prototyping. However, scalable manufacturing methods such as injection molding is costly for low volume production or prototyping since manufacturing of the mold by lithography-based microfabrication techniques is typically expensive. This expense must be distributed over high number of products to reduce the cost per device. Polymer additive rapid tooling, which relies on production of tools (molds and inserts) by additive manufacturing, can be utilized to reduce the tool cost. The idea was coined first about 2 decades ago, but it did not gain attention until recent years, when additive manufacturing and more popularly 3D printing became widespread. However, polymer rapid tooling for fabrication of plastic microfluidic devices still did not receive considerable attention. Noting the capabilities and dimensional resolution of additive manufacturing have been improved in the recent years, for the first time in the literature we propose that polymer rapid tooling can be used for manufacturing of thermoplastic microfluidic lab-on-a-chip devices by injection molding. Thus, by utilizing PRT, it could be possible to reduce the tool cost and a scalable manufacturing scheme can be used for prototyping and low-volume manufacturing of microfluidic devices. Therefore, in this study, it is aimed to design and fabricate polymer tools (inserts) by additive manufacturing techniques (namely stereolithography, SLA) for fabrication of thermoplastic microfluidic devices by injection molding. Injection molding and SLA process parameters will be optimized to maximize the fidelity of the features and to minimize the feature size. Optimized method will be adopted to manufacture a demonstrator microfluidic in vitro diagnostic chip. The method can be extended for rapid additive manufacturing of metal tools by selective laser melting (SLM) or selective laser sintering (SLS) to be used in hot embossing of thermoplastic microfluidic devices.

ESR 17:

Additive Manufacturing Of Functionally Graded Materials (FGM) For Morphing Wings

Option: I

Institution: METU

Supervisor: Yavuz Yaman, Prof., (M)

Co-Supervisor(s): Metin U. Salamci, Prof. (GU, TURKEY) (M)

Short description of the project

Fully morphing wing structures mimic the behavior of nature and are believed to provide greater aerodynamic efficiency and cleaner flight and skies. Various international projects, such as 'Clean Sky', are gathering pace for more efficient and greener air travel. Functionally graded materials (FGM) on the other hand may find an application field in the trailing edges of the fully morphing aircraft wings because of their variable stiffness (expectation is very low in-plane stiffness and very-high out-of-plane stiffness) and low mass characteristics. The required wing components can be manufactured from these materials through the 3D and 4D additive manufacturing techniques. This study will involve the design, characterization, and manufacturing of some trailing edge components having FGMs.

Additive Manufacturing (AM) of FGMs is a promising and interdisciplinary research field that involves (i) the FGM design through the computational material science, (ii) process parameter investigations by means of multiphysics –such as heat, continuity, momentum, Cahn-Hilliard - etc. equations, (iii) Design for Additive Manufacturing and (iv) AM and characterizations.

This research will cover AM of FGMs to be used in the design and manufacturing of Morphing Wings. Based on the design requirement(s) of the Morphing Wings, appropriate FGM will be considered such that weldability and other related material design stages are handled. Process parameters will be developed for the AM of FGM and prototype(s) will be produced.

Vibration Characteristics Of Additively Manufactured Structures With Functionally Graded Materials (FGM)

Option: II
Institution: METU
Supervisor: Yavuz Yaman, Prof., (M)
Co-Supervisor(s): Metin U. Salamci, Prof. (GU, TURKEY) (M)

Short description of the project

Fully morphing wing structures mimic the behavior of nature and are believed to provide the greater aerodynamic efficiency and the cleaner flight and skies. Various international projects, such as ‘Clean Sky’, are gathering pace for more efficient and greener air travel. Functionally graded materials (FGM) on the other hand may find an application field in the trailing edges of the fully morphing aircraft wings because of their variable stiffness (expectation is very low in-plane stiffness and very-high out-of-plane stiffness) and low mass characteristics. The relevant wing components can be manufactured from these materials. This study will involve the design and analysis of the vibratory behavior of the trailing edge components which had been manufactured by using FGMs. The modal characteristics (natural frequencies, mode shapes and modal damping coefficients) obtained will be used in determination of aircraft wing dynamic behavior and/ or aeroelastic characteristics such as the flutter and limit cycle oscillation features. The intended study will use the FGM component material characteristics and will include the extensive structural modelling of the components. Analytical models, Finite Element Models (FEM) and wherever applicable the code development will be the relevant steps of the modelling phase. The vibratory characteristics of the FGM components alone will be determined and various boundary conditions will be modelled in order to represent the component, component+ wing, component+ wing+ aircraft behaviors. The ensuing analysis will involve in-vacuo analysis studies in order to obtain the modal characteristics. Further studies including the effects of aerodynamic loading will also be analyzed. Wind tunnel application of selected combinations will also be attempted for the verification of the developed codes and models.

ESR 18:

Mechanical Behavior Of Additively Manufactured 7xxx Aluminum Alloys: Design Guide For Processing And Post Processing

Option: I

Institution: ITU

Supervisor: Hüseyin Kızıl, Prof., (M)

Co-Supervisor(s): Elmas Salamcı, Assoc. Prof. (GU, TURKEY) (F)

Short description of the project

For 90 years, aluminum alloys have been the materials of choice for both military and commercial aircraft structures. The ingot metallurgy (IM) alloys of the 2000 (Al-Cu-Mg) and 7000 (Al-Zn-MgCu) series used thus far show several disadvantages caused by the production process. Such problems are primarily coarse intermetallic constituent phases, coarse grains, and macrosegregation, resulting in low fracture toughness. Recent advances in aluminum alloy and temper development are maintaining aluminum alloys as the materials of choice for near future commercial aircraft structures to meet cost and weight savings objectives. Aluminum producers have increased research activity in the area of advanced aluminum alloys to provide improved performance characteristics. During the past decade increased efforts have been made to improve the structural efficiency and properties of aerospace materials through the development of lighter weight, stiffer and stronger materials via rapid solidification processing as the processing improves the mechanical properties of many alloys in terms of increased tensile strength, ductility and fatigue and crack propagation resistance. Such improvements are mainly associated with large solid solubility extensions of alloying elements, reduced macrosegregation, refinement of the alloy grain size and changes in the second phase particle size, shape and distribution due to high cooling rates (possibly exceeding 106 K s−1).

Proposed research:

The research will investigate Additive Manufacturing (AM) of 7xxx series alloys, specifically exploring the rapid solidification mechanism during the AM process. The effects of process parameters on the final mechanical behavior of product –such as energy density, exerted power, scanning velocity, etc.- will be documented for the design guide of 7xxx series alloys. Post-processing methodologies will also be developed in order to complete the AM process of 7xxx series alloys. Specimens will be manufactured for the mechanical test and microstructure investigations will be carried out to correlate the relevant process parameters with the final product.

ESR 19:

Design Of Components And Additive Manufacturing Routes For Damage-Resistant Metallic Material

Option: I

Institution: ITU

Supervisor: Hüseyin Kızıl, Prof., (M)

Co-Supervisor(s): Hakan Yavaş, Ph.D. (TUSAS, Turkey) (M)/ Andrea Cini, Ph.D. (Universidad Carlos III Madrid, SPAIN) (M)/ Gustavo M. Castelluccio, Ph.D. (Cranfield University, UK) (M)

Short description of the project

Novel 3D printing of metallic materials (also called additive manufacturing) is starting a manufacturing revolution thanks to its flexibility in adapting functionality, processing, and materials. However, components manufactured this way have relatively low levels of reliability due to a highly variable manufacturing process, which hinder their acceptance.

Proposed research:

Several initiatives have been recently launched to quantify the uncertainty of structural properties in additive manufacturing parts, but there is a notable lack of research on complex loading conditions such as cyclic deformation. Thus, a fundamental understanding of the effects of manufacturing attributes on damage tolerance is required for components and structures to be safely introduced in safety-critical applications.

This PhD project will explore the synergies among manufacturing setups, materials degradation, and component design to identify optimization strategies. The work will involve the creation of a database that compiles the mechanical and materials characterization of the additive manufacturing materials that will inform computational algorithms. By integrating dissimilar data, we aimed to discover the link among structure, processes, and properties, which can be further coupled with the component design for an integrated optimization. As a result, the student will demonstrate the design of additive manufacturing components that are damage resistant.

ESR 20:

Roadmap For AM Airframe Primary Structures Implementation And Certification

Option: I

Institution: ITU

Supervisor: Hüseyin Kızıl, Prof., (M)

Co-Supervisor(s): Fahrettin Öztürk, Prof. (TUSAS, TURKEY) (M)/ Hakan Yavaş, Ph.D. (TUSAS, Turkey) (M)/ Andrea Cini, Ph.D. (Universidad Carlos III Madrid, SPAIN) (M)/ Gustavo M. Castelluccio, Ph.D. (Cranfield University, UK) (M)

Short description of the project

Metallic 3D printing will represent an ideal solution for aircraft primary structure enabling extended component integration by a cheaper and faster and greener production technology. However, no approved methods and model to assess damage tolerance capabilities are currently available for AM part certification due to the lack of knowledge regarding the fatigue failure mechanisms of AM components, exacerbated by the absence reliable NDT techniques and process monitoring.

Proposed research:

The research will rationalize damage mechanisms occurring inside AM components under fatigue loading based on dedicated experimental fatigue test results, NDT inspections and fractography analyses. Development of cracks from manufacturing-induced defects and their propagations up to detectable flow size will be described assessing the effect of defect distribution, crack coalescence, material microstructure and residual stresses. Damage characterization tests will help distinguishing different growth stages below NDT detection threshold. Crack propagation inside the inspectable range will be also characterized and compared with growth rates of conventionally manufactured components to assess the defect distribution and microstructure influence, microplasticity on crack growth variability.

An industrially relevant fatigue life prediction model will be developed on the basis of fatigue prediction methods to assess damage tolerance and define maintenance and inspection plans for AM. Simplified surrogated models to be used as design and in-service damage tolerance assessment tool will be developed from the FE nucleation and propagation results. Material uncertainties will be also included for both slow crack growth approach of single crack and probabilistic widespread fatigue damage assessment.

ESR 21:

Crushing Behavior LTSs (Weight-Optimized Ti-based Lattice Structures For Impact Load Mitigation)

Option: I

Institution: IZTECH

Supervisor: Mustafa Güden, Prof., (M)

Co-Supervisor(s): Hakan Yavaş, Ph.D. (TUSAS, Turkey) (M)

Short description of the project

Cellular metallic structures (CMSs) are made of regularly arranged and distributed cells, exhibiting multi-functional properties [1-5]. CMCs have relatively high bending strength to weight ratios [2] and relatively high resistances to frontal impacts [6]. They are classified random or periodic [3]. In random cell structures like open and closed cell metal foams, the cell size and the geometry vary with the location. The periodic CMSs include honeycombs and corrugated and lattice truss structures (LTSs). The repeating unit topology may be 2D like in a honeycomb, or 3D like in a LTS. LTSs show high bending stresses and stretch-dominated deformation behavior [7] and therefore considered alternative to honeycombs and metallic foams in the applications designed for the mitigation of induced stress waves in impact loading. The most widely investigated topologies until 2015 were tetrahedral [7-10], pyramidal [11-13] and kagome [9, 14-16], which were processed using conventional sheet metal forming methods [17]. With the development of additive manufacturing techniques such as Selective Laser Melting (SLM) and Electron Beam Melting (EBM), there have been significant increase in research and development on LTSs (Figures 1(a) and (b)).

The fabrication of wide range of truss morphologies that can allow the designing structures with LTSs for fine-tuned mechanical properties are now possible with additive manufacturing [18]. Two possible applications of LTSs in impact load mitigation are foreseen: i) impact load resistant packaging and ii) impact load protection. The valuable, fragile equipment are protected from accidental damages with the use LTS-cored sandwich structure cage (e.g. the package may be dropped from a height during transportation). The vehicles, ships, and planes are protected from outside impact loadings in which LTS-cored sandwich is either mounted onto the outer surface of vehicle or the outer surface of vehicle is solely made of LTS-cored sandwich (i.e. bird strike to the radom of airplanes). In these applications, LTSs are expected to transfer relatively low stresses to the packaged/protected structure and should absorb much of the kinetic energy of impact through plastic buckling/stretching of trusses. The current research activities on LTSs have mostly focused on Ti and its alloys particular on Ti64. Ti64 satisfies both structural and functional requirements for load bearing applications by a combination of mechanical, physical and chemical properties. Because of relatively light-weight and bio-compatibility, Ti64 has found a wider usage in medical and dental applications [18]. Their light-weight and higher strength ratio per unit weight are also extremely suitable for jet engines and many components in airframe [4–6]. In the aerospace industry “buy-to-fly” ratio (mass of raw metal to mass of product) are 12-25:1 and with the use of additive manufacturing techniques it declines to 3-12:1 [19]. The high corrosion resistance of Ti64 is attracted by marine and chemical industries [3,7]. So far 16, topologically different, Ti64 LTSs have been reported in the literature, see Table 1. Majority of studies on these LTSs were on the quasi-static mechanical response [20-26], while there have been only few studies on the dynamic mechanical behavior of Ti64 LTSs [24, 27].

The aim of the proposed project is to ascertain and fabricate certain topologies of Ti64 LTSs, which would be used in impact load mitigation for packaging and protection. Since, the comparison between different LTSs will be made at the same relative density, the determined LTSs will be also optimized in terms of weight. The material models (flow stress and damage) of AM Ti64 are needed in the simulations and will be determined experimentally and compared with the existent models in the literature. The validity of these models will be verified and a library of material models of AM Ti64 alloy will be established.

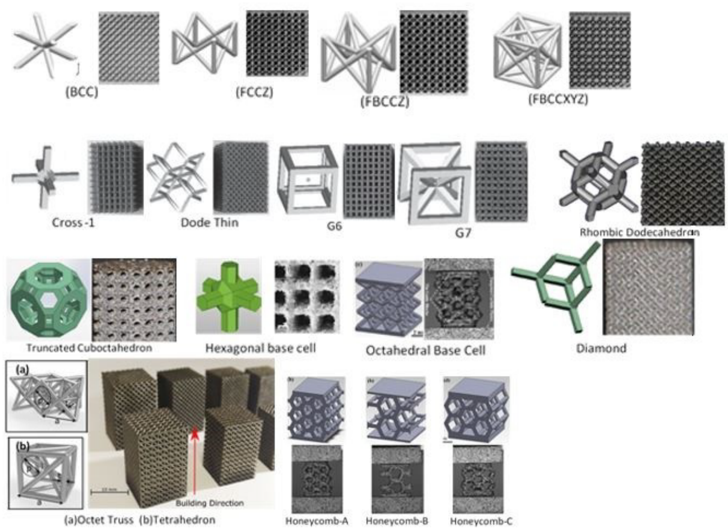
The crushing models of LTSs at quasi-static and dynamic velocities will be developed and implemented in explicit FEM software of LS-DYNA. The results of these simulations will provide very valuable designing criteria for both static and dynamic loading of LTSs. Analytical scaling equations for the mechanical response of LTSs (elastic modulus, crushing stress, densification strain, critical strain for densification and critical velocity for shock stress development) will also be established based on numerical and experimental static and dynamic tests. The geometrical parameters that affect the critical velocity for shock deformation will also be developed.

Table 1 The Ti64 LTSs investigated in the literature

Lattice Name

Body centered cubic (BCC) [41]
Face centered cubic with vertical struts (FCCZ) [41]
Face and body-centered cubic with vertical axis struts (FBCCZ) [41]
Face and body centered cubic with horizontal and vertical axis and struts (FBCCXYZ) [41]
Cross 1 [42, 43]
Dode Thin [42, 43]
G6(Cubic) [42, 44-48]
G7 [42, 44-48]
Rhombic Dodecahedron [48-51]
Truncated Cuboctahedron
Hexagonal [43, 52]
Octahedral [43, 52]
Diamond [48, 53, 54]
Octet Truss [55]
Tetrahedron [55]
Honeycomb [43]

Structure



References

[1] Gibson and Ashby, Cellular Solids: Structure and Properties, Cambridge University Press Cambridge, 1997. [2] A.G. Evans, J.W. Hutchinson, M.F. Ashby, Progress in Materials Science 43 (1998) 171-221. [3] A.G. Evans, J.W. Hutchinson, N.A. Fleck, M.F. Ashby, H.N.G. Wadley, Progress in Materials Science 46 (2001) 309-327. [4] H.N.G. Wadley, Philosophical Transactions of the Royal Society a-Mathematical Physical and Engineering Sciences 364 (2006) 31-68. [5] D.D. Radford, G.J. McShane, V.S. Deshpande, N.A. Fleck, International Journal of Solids and Structures 43 (2006) 2243-2259. [6] K.P. Dharmasena, H.N.G. Wadley, Z.Y. Xue,

J.W. Hutchinson, International Journal of Impact Engineering 35 (2008) 1063-1074. [7] G.W. Kooistra, V.S. Deshpande, H.N.G. Wadley, Acta Materialia 52 (2004) 4229-4237. [8] Y. Sugimura, Mechanics of Materials 36 (2004) 715-721. [9] J.-H. Lim, K.-J. Kang, International Journal of Solids and Structures 43 (2006) 5228-5246. [10] H.J. Rathbun, Z. Wei, M.Y. He, F.W. Zok, A.G. Evans, D.J. Sypeck, H.N.G. Wadley, Journal of Applied Mechanics 71 (2004) 368. [11] S. Lee, F. Barthelat, J.W. Hutchinson, H.D. Espinosa, International Journal of Plasticity 22 (2006) 2118-2145. [12] D.D. Radford, N.A. Fleck, V.S. Deshpande, International Journal of Impact Engineering 32 (2006) 968-987. [13] C.J. Yungwirth, H.N.G. Wadley, J.H. O'Connor, A.J. Zakraysek, V.S. Deshpande, International Journal of Impact Engineering 35 (2008) 920-936. [14] S. Hyun, A.M. Karlsson, S. Torquato, A.G. Evans, International Journal of Solids and Structures 40 (2003) 6989-6998. [15] J. Wang, A.G. Evans, K. Dharmasena, H.N.G. Wadley, International Journal of Solids and Structures 40 (2003) 6981-6988. [16] X.C. Zhang, Y. Liu, B. Wang, Z.M. Zhang, International Journal of Mechanical Sciences 52 (2010) 1290-1298. [17] H.N. Wadley, Philos Transact A Math Phys Eng Sci 364 (2006) 31-68. [18] X.Z. Zhang, M. Leary, H.P. Tang, T.

Song, M. Qian, Current Opinion in Solid State & Materials Science 22 (2018) 75-99. [19] S. Liu, Y.C. Shin, Materials and Design 164 (2019). [20] S.Y. Choy, C.N. Sun, K.F. Leong, J. Wei, Additive Manufacturing 16 (2017) 213-224. [21] V. Crupi, E. Kara, G. Epasto, E. Guglielmino, H. Aykul, Materials & Design 135 (2017) 246-256. [22] L. Dong, V. Deshpande, H. Wadley, International Journal of Solids and Structures 60-61 (2015) 107-124. [23] L.J. Xiao, W.D. Song, C. Wang, H.P. Liu, H.P. Tang, J.Z. Wang, Materials Science and Engineering a-Structural Materials Properties Microstructure and Processing 640 (2015) 375-384. [24] L.J. Xiao, W.D. Song, C. Wang, H.P. Tang, Q.B. Fan, N. Liu, J.Z. Wang, International Journal of Impact Engineering 100 (2017) 75-89. [25] M. Mahbod, M. Asgari, International Journal of Mechanical Sciences 155 (2019) 248-266. [26] X.C. Yan, Q. Li, S. Yin, Z.Y. Chen, R. Jenkins, C.Y. Chen, J. Wang, W.Y. Ma, R. Bolot, R. Lupoi, Z.M. Ren, H.L. Liao, M. Liu, Journal of Alloys and Compounds 782 (2019) 209-223. [27] Z. Ozdemir, A. Tyas, R. Goodall, H. Askes, International Journal of Impact Engineering 102 (2017) 1-15. [28] C.R. Calladine, R.W. English, International Journal of Mechanical Sciences 26 (1984) 689-&. [29] L.L. Tam, C.R. Calladine, International Journal of Impact Engineering 11

(1991) 349-377. [30] H. Zhao, I. Elnasri, S. Abdennadher, International Journal of Mechanical Sciences 47 (2005) 757-774. [31] M. Langseth, O.S. Hopperstad, International Journal of Impact Engineering 18 (1996) 949-968. [32] A. Paul, U. Ramamurty, Materials Science and Engineering a-Structural Materials Properties Microstructure and Processing 281 (2000) 1-7. [33] S.R. Reid, C. Peng, International Journal of Impact Engineering 19 (1997) 531-570. [34] V.L. Tagarielli, V.S. Deshpande, N.A. Fleck, Composites Part B-Engineering 39 (2008) 83-91. [35] D.T. Queheillalt, H.N.G. Wadley, Materials Science and Engineering: A 397 (2005) 132-137. [36] H. Wadley, K. Dharmasena, Y. Chen, P. Dudt, D. Knight, R. Charette, K. Kiddy, International Journal of Impact Engineering 35 (2008) 1102-1114. [37] K.P. Dharmasena, H.N.G. Wadley, K. Williams, Z. Xue, J.W. Hutchinson, International Journal of Impact Engineering 38 (2011) 275-289. [38] G.J. McShane, S.M. Pingle, V.S. Deshpande, N.A. Fleck, International Journal of Solids and Structures 49 (2012) 2830-2838. [39] P.J. Tan, S.R. Reid, J.J. Harrigan, Z. Zou, S. Li, Journal of the Mechanics and Physics of Solids 53 (2005) 2174-2205. [40] Z. Zou, S.R. Reid, P.J. Tan, S. Li, J.J. Harrigan, International Journal of Impact Engineering 36 (2009) 165-176.

[41] M. Mazur, M. Leary, S. Sun, M. Vcelka, D. Shidid, M. Brandt, The International Journal of Advanced Manufacturing Technology 84 (2016) 1391-1411. [42] L.E. Murr, S.M. Gaytan, F. Medina, H. Lopez, E. Martinez, B.I. Machado, D.H. Hernandez, L. Martinez, M.I. Lopez, R.B. Wicker, J. Bracke, Philosophical Transactions of the Royal Society a-Mathematical Physical and Engineering Sciences 368 (2010) 1999-2032. [43] M. Jamshidinia, L. Wang, W. Tong, R. Kovacevic, Journal of Materials Processing Technology 214 (2014) 1728-1739. [44] S.J. Li, Q.S. Xu, Z. Wang, W.T. Hou, Y.L. Hao, R. Yang, L.E. Murr, Acta Biomaterialia 10 (2014) 4537-4547. [45] J. Parthasarathy, B. Starly, S. Raman, Journal of Manufacturing Processes 13 (2011) 160-170. [46] J. Parthasarathy, B. Starly, S. Raman, A. Christensen, Journal of the Mechanical Behavior of Biomedical Materials 3 (2010) 249-259. [47] E. Sallica-Leva, A.L. Jardini, J.B. Fogagnolo, Journal of the Mechanical Behavior of Biomedical Materials 26 (2013) 98-108. [48] S.A. Yavari, S.M. Ahmadi, R. Wauthle, B. Pouran, J. Schrooten, H. Weinans, A.A. Zadpoor, Journal of the Mechanical Behavior of Biomedical Materials 43 (2015) 91-100. [49] T.J. Horn, O.L.A. Harrysson, D.J. Marcellin-Little, H.A. West, B.D.X. Lascelles, R. Aman, Additive

Manufacturing 1-4 (2014) 2-11. [50] S.J. Li, L.E. Murr, X.Y. Cheng, Z.B. Zhang, Y.L. Hao, R. Yang, F. Medina, R.B. Wicker, Acta Materialia 60 (2012) 793-802. [51] O.L.A. Harrysson, O. CansiZoglu, D.J. Marcellin-Little, D.R. Cormier, H.A. West, Materials Science & Engineering C-Biomimetic and Supramolecular Systems 28 (2008) 366-373. [52] L.A. Dobrzański, A.D. Dobrzańska-Danikiewicz, T.G. Gaweł, A. Achtelik-Franczak, 60 (2015) 2039. [53] V.J. Challis, X.X. Xu, L.C. Zhang, A.P. Roberts, J.F. Grotowski, T.B. Sercombe, Materials & Design 63 (2014) 783-788. [54] R. Wauthle, B. Vrancken, B. Beynaerts, K. Jorissen, J. Schrooten, J.-P. Kruth, J. Van Humbeeck, Additive Manufacturing 5 (2015) 77-84. [55] S. Arabnejad, R.B. Johnston, J.A. Pura, B. Singh, M. Tanzer, D. Pasini, Acta Biomaterialia 30 (2016) 345-356. [56] T.J. Holmquist, G.R. Johnson, Journal De Physique Iii 1 (1991) 853-860. [57] M. Çakırcalı, C. Kılıçaslan, M. Güden, E. Kıranlı, V.Y. Shchukin, V.V.J.T.I.J.o.A.M.T. Petronko, 65 (2013) 1273-1287. [58] Y.C. Lin, X.M. Chen, G. Liu, Materials Science and Engineering a-Structural Materials Properties Microstructure and Processing 527 (2010) 6980-6986. [59] H. Huh, K. Ahn, J.H. Lim, H.W. Kim, L.J. Park, Journal of Materials Processing Technology 214 (2014) 1326-1340. [60]

D. Samantaray, S. Mandal, A.K. Bhaduri, Computational Materials Science 47 (2009) 568-576. [61] C.Y. Gao, L.C. Zhang, Materials Science and Engineering a-Structural Materials Properties Microstructure and Processing 527 (2010) 3138-3143.

ESR 22:

Dynamic Behavior Of AM Parts (Dynamic Behavior And Constitutive Equations Of Additively Manufactured Metallic Alloys)

Option: I
Institution: IZTECH
Supervisor: Alper Taşdemirci, Prof., (M)
Co-Supervisor(s): İlhan ŞEN, Ph.D. (TUSAS, Turkey) (M)

Short description of the project

Additively manufactured (AM) metallic alloy parts exhibit different microstructures; hence, different mechanical properties from their conventionally manufactured counterparts. High cooling rates involved in AM inherently induce high dislocation density and fine microstructure development. As is known, high dislocation density and fine cellular structure promote twinning deformation in conjunction with slip, and somehow they compete to each other at varying strains, strain rates and temperatures making the deformation very much complicated. The main aim of this thesis is to determine appropriate flow stress and damage models of AM Ti64 and 316L alloys. In the first part of this thesis, extensive testing at both static and dynamic strain rates will be performed to determine the constitutive equations. In the second part, the test sample processing will be simulated using the commercial finite element code of ANSYS/Additive module and then the samples will be transferred to LSDYNA to simulate mechanical testing. Part one and part two will work together to validate the fidelity of the constitutive equations developed. Extensive mechanical characterization including reloading at different pre-strains from static to dynamic and vice-verse and microstructural analysis will be performed to determine the deformation history effect. Additionally, the effect of adiabatic heating on the deformation behavior of these alloys is also determined. The proposed project studies will be performed at the Dynamic Testing and Modelling Laboratory of İzmir Institute of Technology. The lab is equipped with compression and tensile Split Hopkinson Bar, projectile impact set-up, drop weight tester and universal tension and compression machine and has a license and a long-time user of LSDYNA.

1004 PROJECT

No	Project name	Responsible APYK
1	Production of NACE 30 Coded Prototypes/Test Samples Development of Process and Post-Process Parameters Related to Mechanical, Vibro-Acoustic, Surface Properties	GAZİ UNIVERSITY
2	Additive Manufacturing Test Prototype Development Project Using Electron Beam	ASELSAN
3	Double Laser Pressure Adapter 250 x 250 x 300 mm Automatic Powder Circulation System Additive Manufacturing System	ERMAKSAN
4	Theoretical and Experimental Investigation of Structural and Mechanical Properties of Bulk/Cage Systems Produced from Ti6Al4V Alloy Using Variable Production Parameters by Selective Laser Melting (SLE) Method	ERZURUM TECHNICAL UNIVERSITY
5	Production of Parts Used in Satellite Launching Systems by Powder Bed and Wire-Fed Additive Manufacturing Methods	ROKETSAN
6	Development of Hybrid Directed Energy Deposition (DED) Processes	SABANCI UNIVERSITY
7	Manufacturing and Qualification of Flight Critical Parts and Systems by Additive Manufacturing Methods	TUSAŞ-TAI
8	Production and Qualification of Satellite Systems and Parts by Additive Manufacturing Methods	TUSAŞ-TAI
9	Development of Recycling Processes and Advanced Powder Materials for Additive Manufacturing of Titanium Alloys	TUSAŞ-TAI
10	Additive Manufacturing and Verification of Ceramic Cores for Investment Casting	TEI
11	Design, Production and Characterization of High Temperature Nickel Based Superalloys Suitable for Additive Manufacturing	TEI

12	Developing Superalloy and Stainless Steel Alloy Ingot to Produce Powder Suitable for Additive Manufacturing and Post Processing of Metallic Materials Produced by Additive Manufacturing	TÜBİTAK MAM
13	Social Impact of the Research Program*	GAZİ UNIVERSITY

MORE INFORMATION

https://ektam.gazi.edu.tr