



LUT
University

LUT University AM Activities

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LUT University

Research Group of Laser Materials Processing

Background

- Research in laser materials processing since 1985
- First own laser 1986
- Research was focused to laser welding, laser cladding, laser surface treatment etc. in 1980's and 1990's
- Personnel: 10 persons
- Turn-over c. 1.0 M€/year
- Master Theses c. 6 pcs/year
- Doctoral Theses 1 pcs/year
- Publications c. 15 pcs/year
- Citations > 300/year

Additive manufacturing (AM)

- Research in monitoring of AM since 2009
- Device for metallic AM (EOS M series) 2011
- (EOS M 290, 2019, on delivery)
- Research topics:
 - Process efficiency
 - Product design
 - Design of internal structures
 - Mechanical properties of material
 - Digital tools from idea to printing (Dassault)
- Education in AM for M.Sc. students since 2011



Research in additive manufacturing

Academic



- Academic research (since 2009) on:
 - Understanding laser beam and (metal) material interaction.
 - Testing of mechanical properties
 - Enhancing process efficiency and process control
- Monitoring has been executed by measuring 1) optical emissions of AM process, 2) process temperature and 3) high-speed imaging of process.
- Other topics: Printability of products, costs in AM, sustainability in AM and bottle necks, such as support structures, in industrial implementation, new applications in AM, such as fuel cells, and product development in AM has also been studied.

Research in additive manufacturing



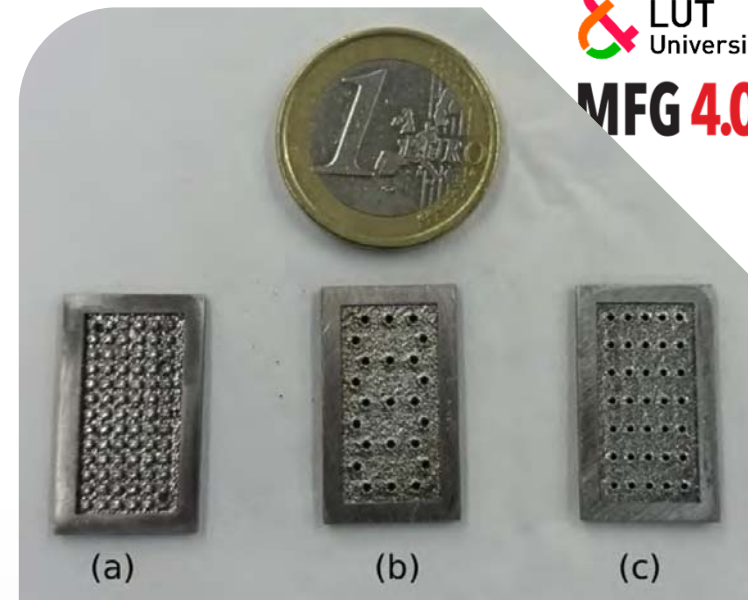
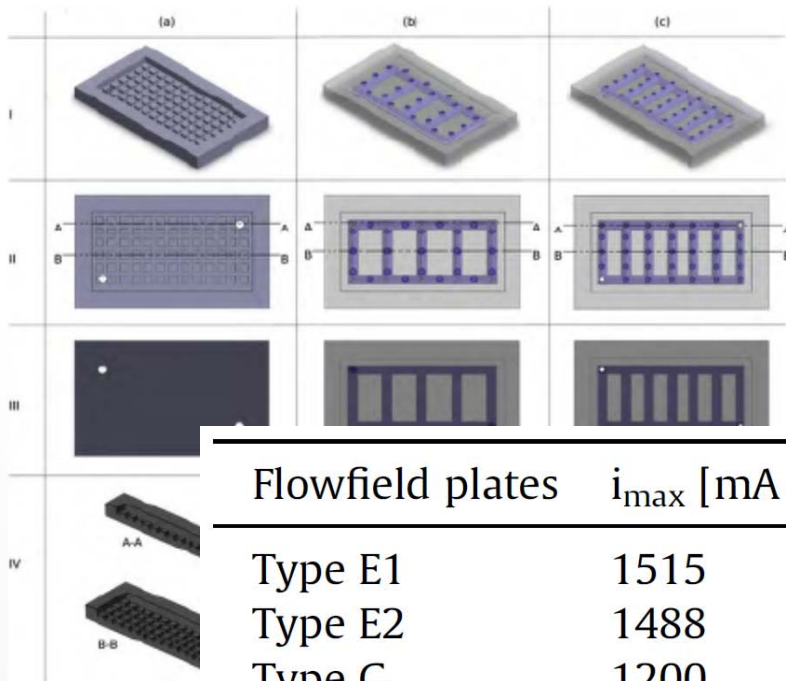
- During 2009-2019 it has been executed at LUT:
 - 50 peer reviewed publications
 - 30 theses (Bachelor Theses and Master Theses)
- LUT is one of leading universities in Finland and in Scandinavia, by number and quality of publications.

Research in additive manufacturing

Industrial

- First projects in LUT in AM were dealing with manufacturing of small-scale devices for chemical industry (microreactors).
- Later, industrial projects of AM of ceramics, welding AM parts to larger constructions and techno-economic aspects of AM.
- LUT has also done R&D with companies and industry in smaller projects, when solutions for manufacturing challenges of companies and industry can be carried out.
 - These projects typically deal with product design, printing of product and application of ready product i.e. covering whole value chain of product.

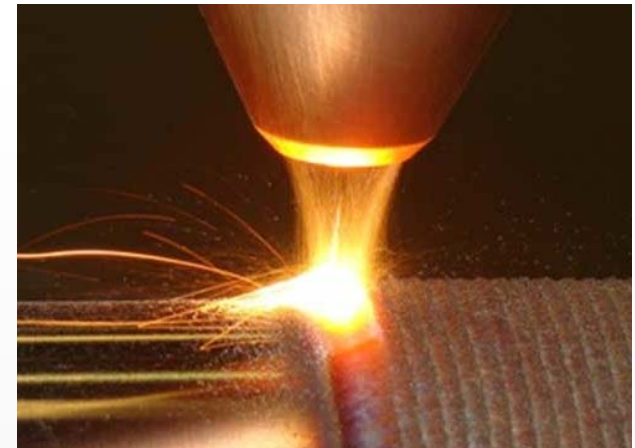
Fuel cell with AM



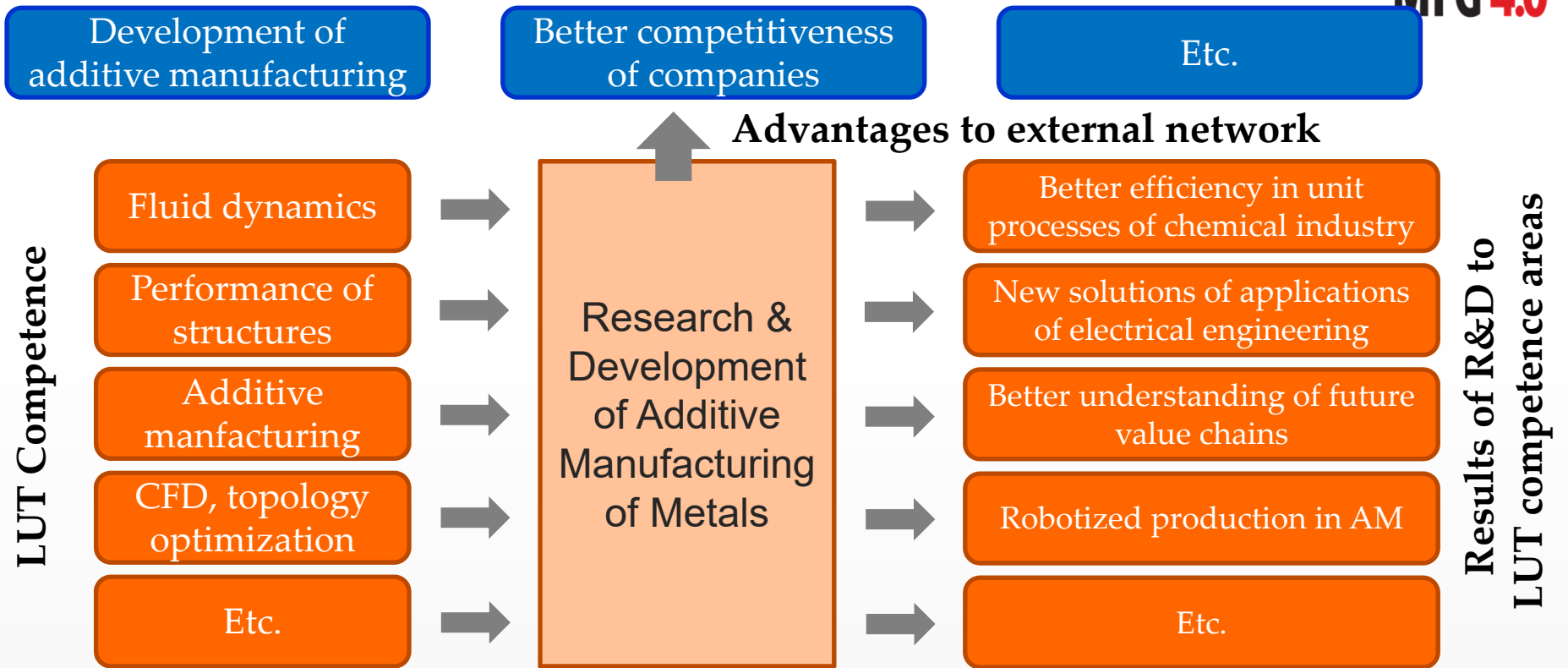
Flowfield plates	i_{\max} [mA cm ⁻²]	P_{\max} [mW cm ⁻²]	OCV [V]	R_{cell} [Ω cm ²]
Type E1	1515	363	0.906	0.446
Type E2	1488	344	0.902	0.504
Type G	1200	238	0.977	0.590

Current topics

- Mechanical properties of printed metal material
- Fatigue of printed components
- Design
- Monitoring
- Wire LMD
 - To enable larger structures
 - To enable higher deposition rate



Target in R&D of AM at LUT



Research in additive manufacturing



- LUT has carried out eight large projects in field of industrial additive manufacturing and these projects are worth of ~3.4 M€.

Research in additive manufacturing

Project	Funding	Time period
Me3di	ERDF	2018 – 2020
3D-tulostuksen kehittäminen "3DIT!"	City of Lappeenranta	2018
Manufacturing 4.0	Strategic Research Council of Finland	2018 – 2023
New Art of Reason "Newarea"	Tekes	2016 – 2019
Micro- and mill structured reactors for catalytic oxidation reactions, "Micatox"	Academy of Finland	2014 – 2017
Hub of Application Laboratories for Equipment Assessment in Laser Based Manufacturing, "APPOLO"	European Union 7th framework project	2013 – 2017
Art residence for creation of feeling based value by advanced manufacturing, "Lares"	Tekes	2014 - 2015
Development of Manufacturing technologies, "Manu P6+P1"	Fimecc Oy / Tekes	2012 - 2015
Fast co-tuning for individual needs "Fast Coins"	Tekes	2013 - 2014
Use of laser in innovative business model generation, "Innobusiness"	Tekes	2010 - 2012
Laser in manufacturing of functional surfaces and structures, "FuncMama"	Tekes	2009 - 2012
Laser based manufacturing of miniature chemical reactors, "FabTech"	Tekes	2009 - 2011

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On-going at the moment

Metal 3D Innovations



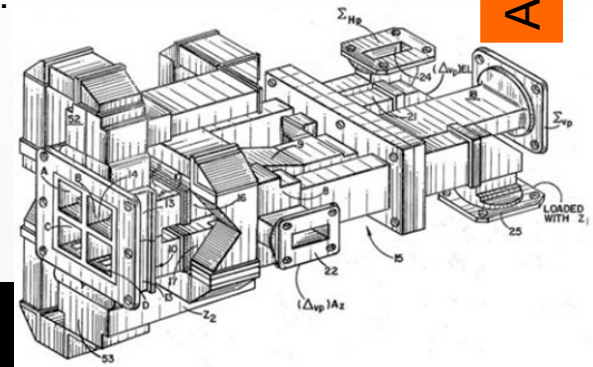
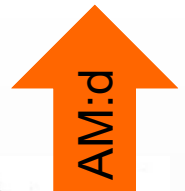
Formation of industrial knowhow cluster of metallic 3D printing to South Karelia by combining regional knowhow in industrial manufacturing and design.

Actions:

1. To identify needs of companies for industrial training in additive manufacturing
2. Company cases
3. Production chain

Result:

1. Companies will understand benefits and potential of additive manufacturing and are able to evaluate how it can be applied to their business.
2. Supply chain in AM becomes clear.



Vipuvoimaa
EU:lta
2014–2020



How will automation
and 3D printing change
the manufacturing ?

MFG 4.0



Strategic Research Council Finland 2017 program: STN 2017 Adaptation and Resilience for Sustainable Growth (2018-2023) (Sopeutuminen kestävän kasvun edellytyksenä)

Volume: 6 years / ~ 6 M€

Realizers: 4 universities, 7 research groups, ~50 researchers, 25 international partners

Research questions:

- Strong foresight for future manufacturing in Finland
- Creation of technology for supporting future manufacturing
- Creation of better intelligent decision-support methods
- Understanding what business models will work for Finland
- Creation of new ideas for how to organize and execute education
- Development of social security models



Education in additive manufacturing

Master's degree

- Education in AM started 2013.
- One aim of education of AM at LUT is to enhance know-how of additive manufacturing, especially in metallic AM, and bring new technology specialists and adopters to Finland.

Course	Credits	Number of students (average)
BK30A0901 Additive Manufacturing – 3D printing	5	43
BK30A0803 Digital Advanced Manufacturing with Lasers	5	26
BK30A1201 Laser Materials Processing	5	25
BK30A1301 Laser Based Manufacturing for Design	5	22
BK30A1000SS Additive Manufacturing - 3D Printing, LUT Summer School Course	3	35
Total:	23	151

Education in additive manufacturing

Doctoral degree



- Post-graduate course was started in 2017 with one course of additive manufacturing.
- Aim is that doctoral degree at LUT can be completed in field of additive manufacturing.

Course	Credits	Amount of students (average)
BK30AJ110 Postgraduate Course in Laser Based Additive Manufacturing and 3D Printing	10	7
Total:	10	7

Education in additive manufacturing

Industrial training



- LUT carried out in 2014 a complete program of "3D printing specialist" in Finnish language.
- Course modules were:
 1. Basics of 3D printing, two days
 2. Work phases in 3D printing, two days
 3. 3D printing techniques and equipment for plastics, two days
 4. 3D printing techniques and equipment for metals, two days
 5. Project work for 3D printing, four days

International co-operation



Thank you for your attention!

Any questions?

