Centr-AI

bias

Bremer Institut für
angewandte Strahltechnik GmbH

Centr-AI:
Solutions for Laser Welding of Aluminum

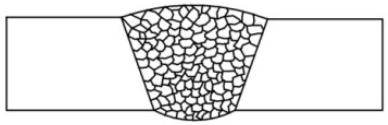
Thomas Seefeld

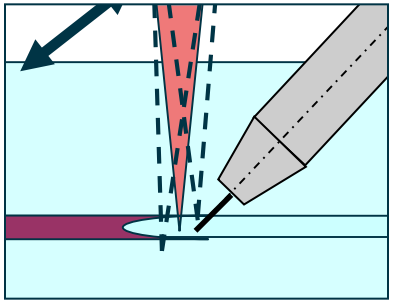
Olofström, October 6, 2011

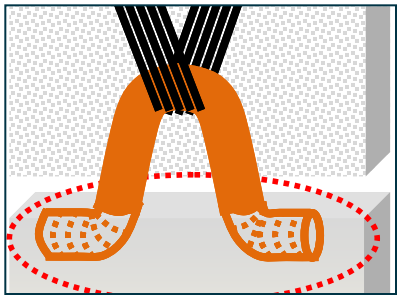
Outline

- Introduction of BIAS
- Introduction of the Center of Competence for Welding of Aluminum Alloys - Centr-Al
- Novel Solutions from R&D
  - Brightness consideration
  - Filler materials
  - Gap bridgeing
  - Hybrid joints

Centr-Al







Bremer Institut für angewandte Strahltechnik

Foundation: 1977

Employees: 120+

Legal structure:
non-commercial
limited Company

Objective:
Research & Development
Technology Transfer in
Laser Materials Processing
and Optical Metrology

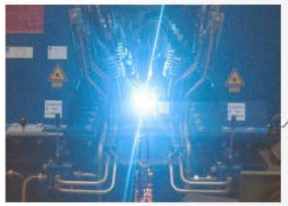
Clients:
Industry & Government

Business Fields and Areas of Activity

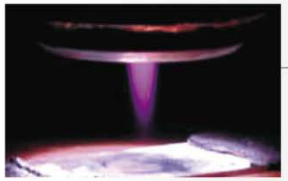
bias

Material Processing and Processing Systems

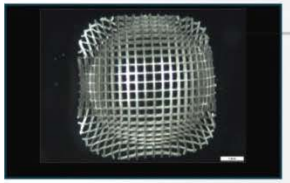
- Joining of Metallic Materials



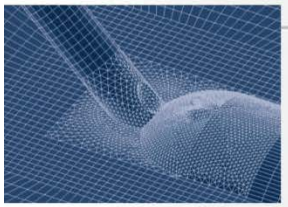
- Controlling Material Properties



- Form Generating Methods



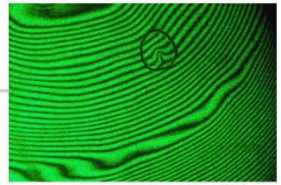
- Process Modelling



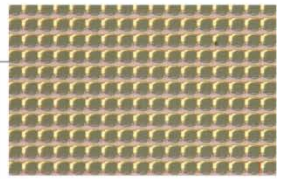
Optical Metrology and Optoelectronic Systems

- Systems for Shape and Deformation Measurement

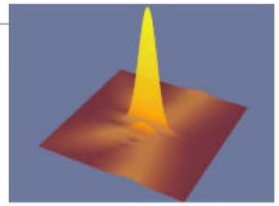
- Nondestructive Testing



- Optoelectronic Systems



- Optical Design and Simulation

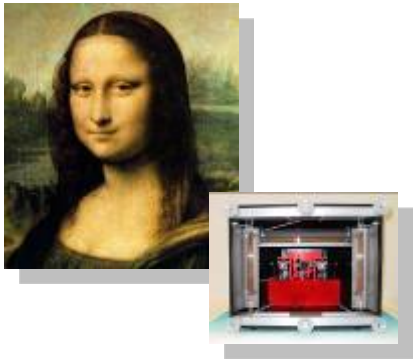


Application Areas

Train Car Manufacturing

Aviation

Artwork



Automotive Engineering

Medical Engineering

Shipbuilding

Profile of Services

- Research and Development
- Consulting
- Technology Studies
- Prototype Manufacturing

What is Centr-Al?

bias

Centr-Al

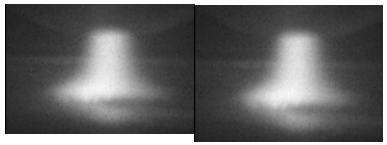
Center of Competence for Welding of Aluminum Alloys

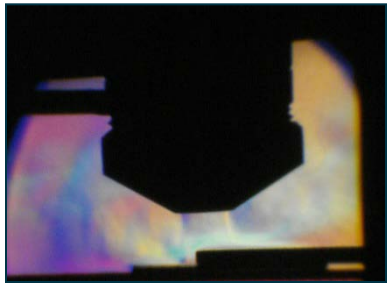
R&D	Knowledge Transfer	Networking
Pre-Studies	Cooperation	Contacts
R&D Projects	Customer Support	Society work
Industry Research	Technical Meetings	Information of the general public
Coordination	Publication	
	Education	

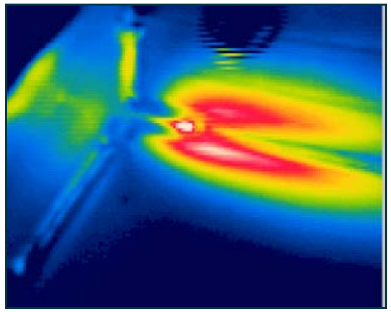
Centr-AI in Facts and Figures

- More than 10 Co-Workers
- 11 publicly funded projects: 2,7 Mio €
- Industry contracts: 1,9 Mio €
- 69 Publications

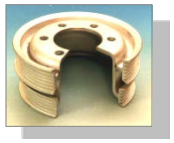
- Bremen based companies in advisory committee:
  - Ingenieurbüro Heidenreich
  - R. Seefried Schweiß- und Montagetechnik
  - Abeking+Rasmussen
  - Atlas Elektronik
  - Mercedes-Benz



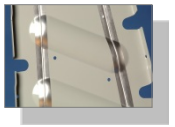


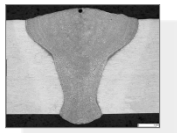


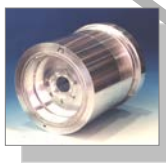
Competence in Aluminum

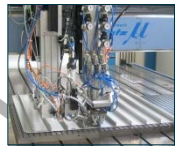

Pilot produktion

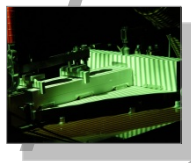

Filler material

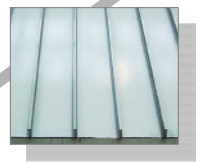

Light structures


Processes


Quality


System technology


Distortion


Improvement

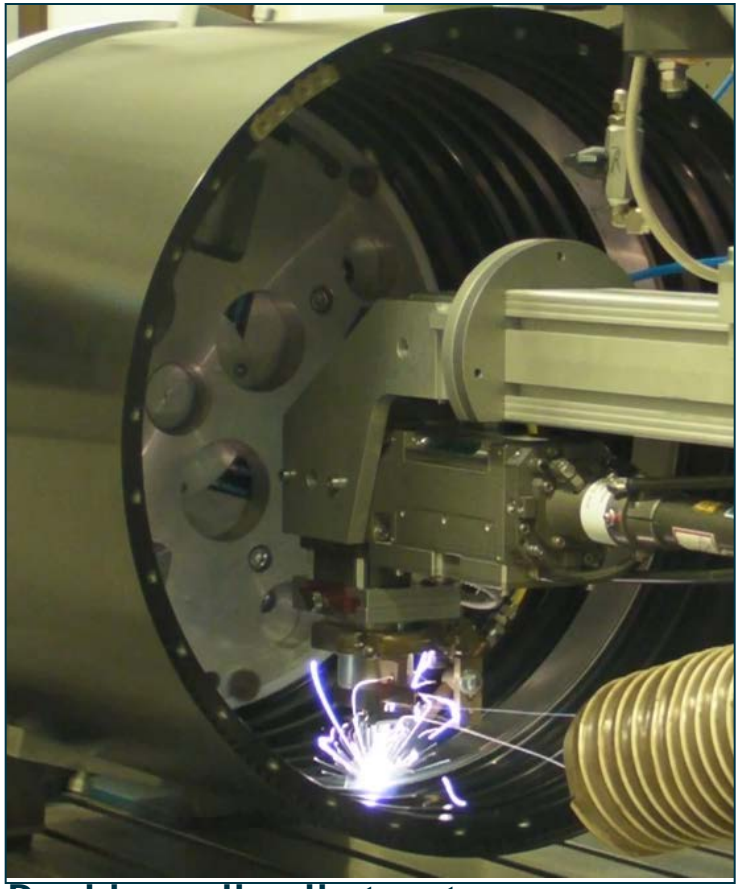
Research and development

Center of Competence for Welding of Aluminum Alloys

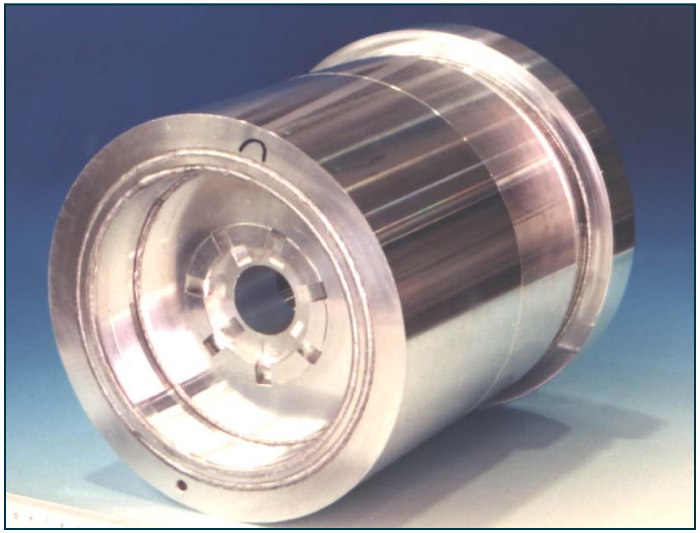
Centr-Al

Application

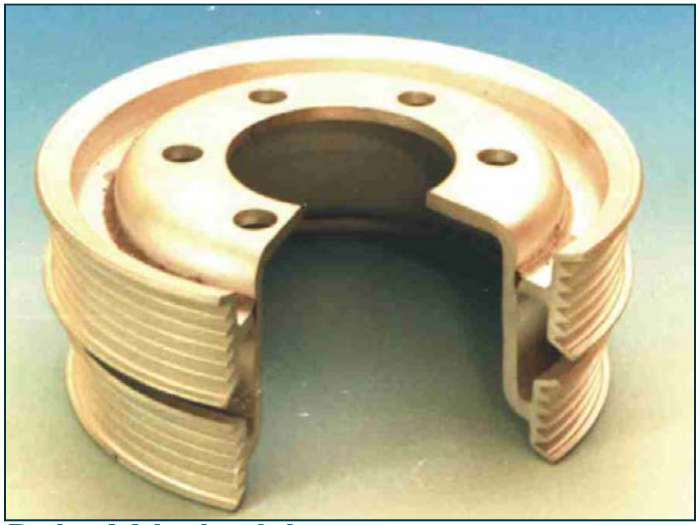
Laser Welding of Aluminum: Examples



Double-wall cell structure



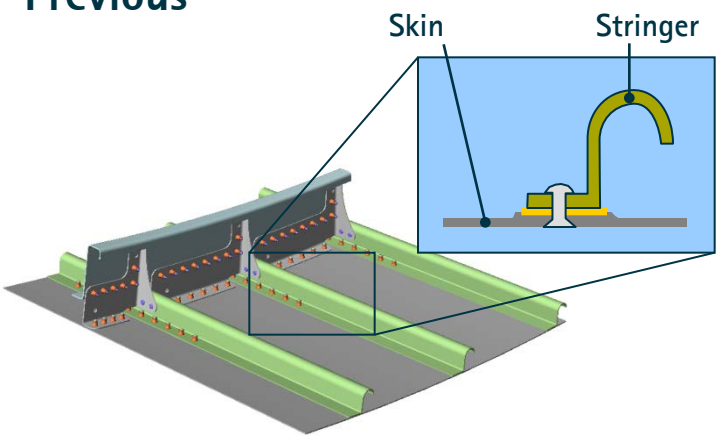
Motor housing



Poly-V belt drive

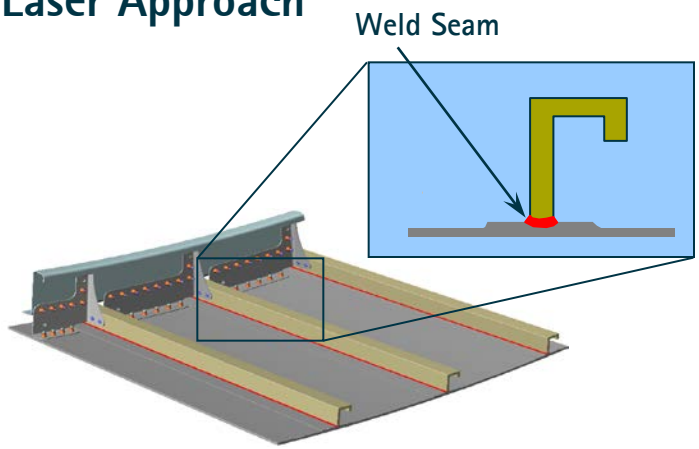
Laser Welded Aircraft Fuselage Panel

Previous



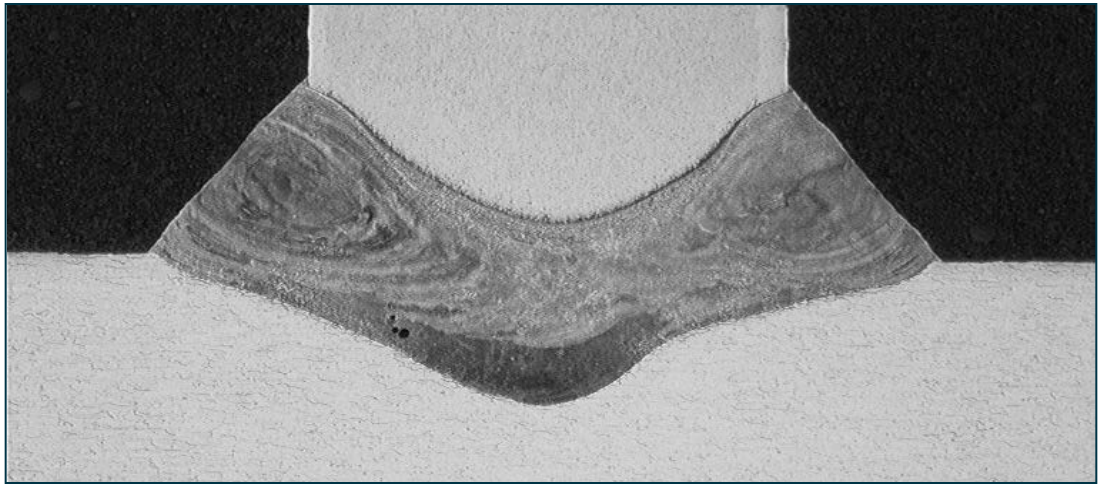
Riveting speed: 0,15-0,25 m/min

Laser Approach



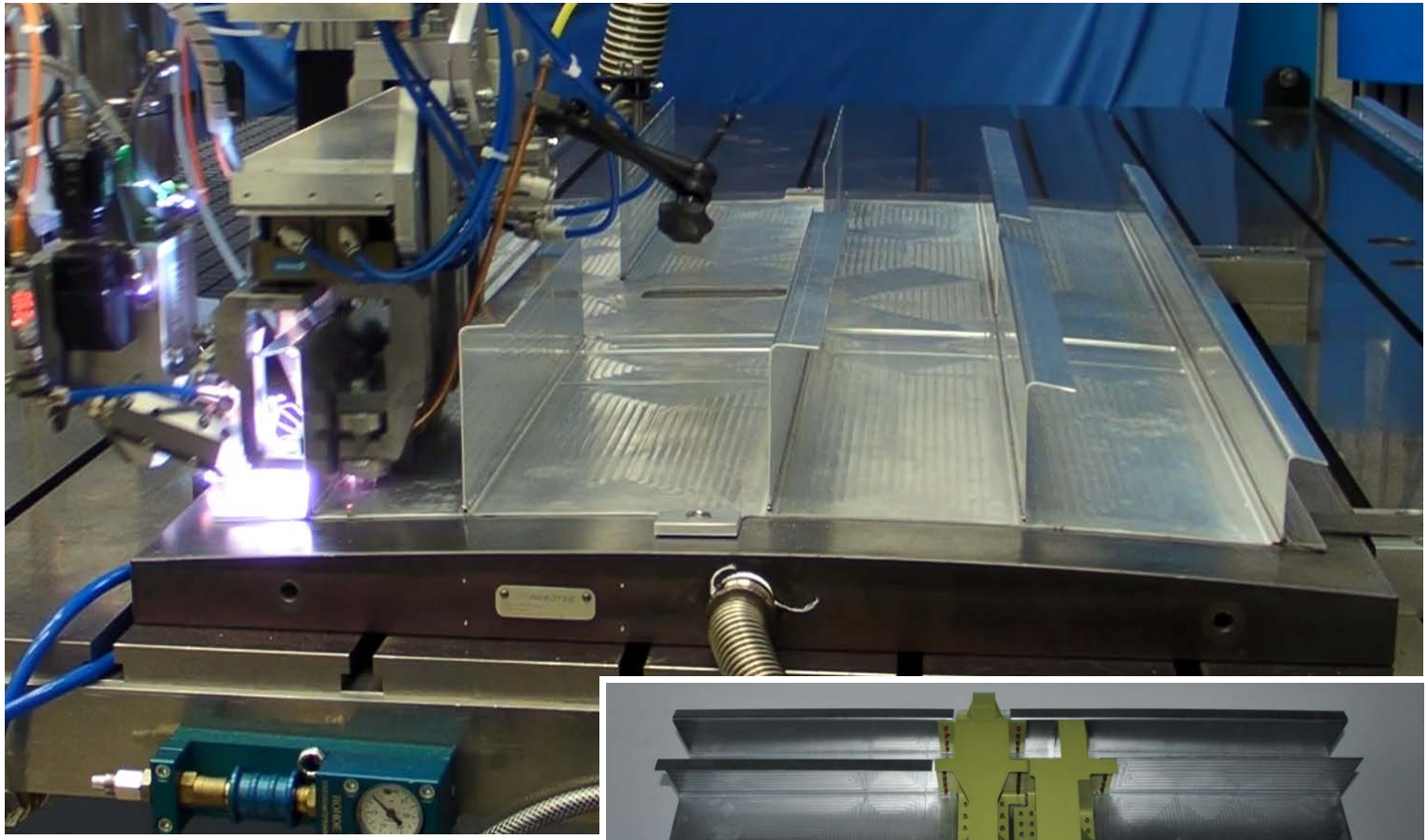
Welding speed: 8-10 m/min

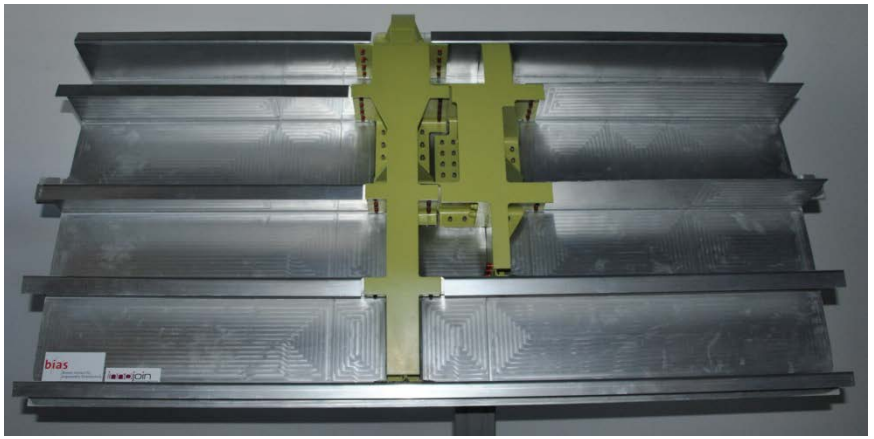
State of the Art



Application:
- A318
- A380
- A340 HGW

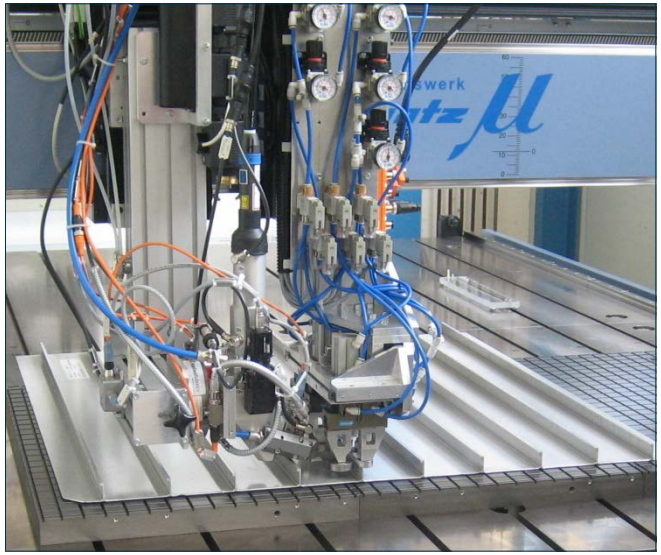
Laser Welded Flap Design

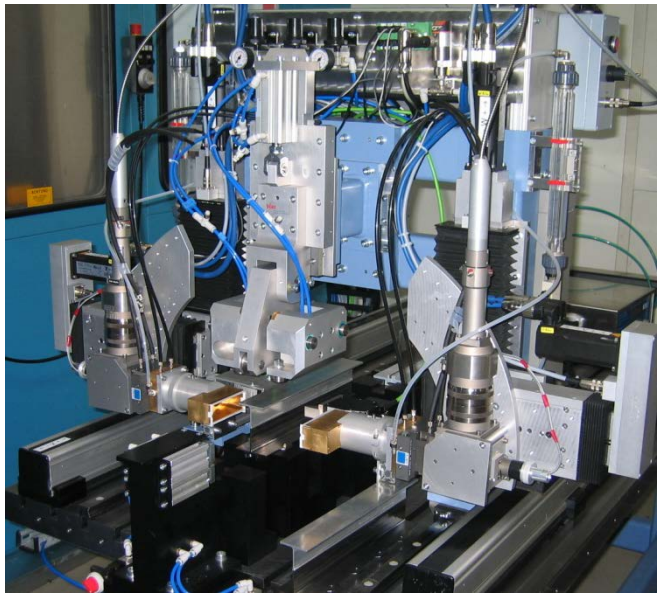


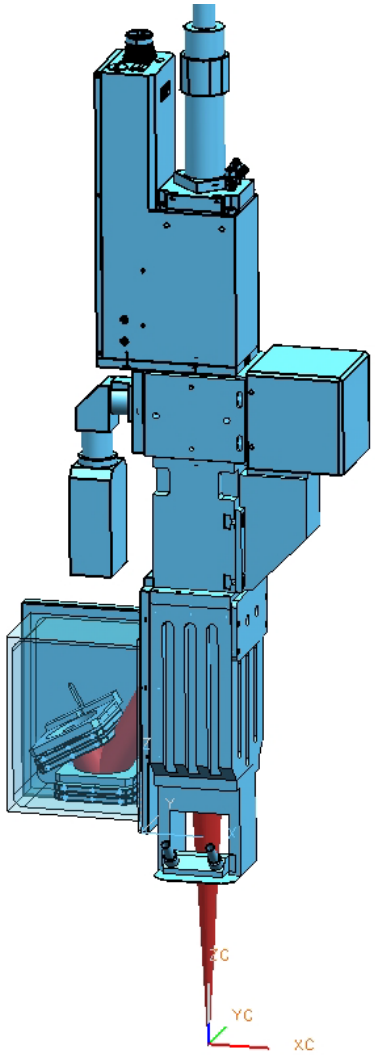


Material	AlMgSc
Beam source:	TruDisk 8002
Output power:	6 kW
Welding speed:	15 m/min

System Technology



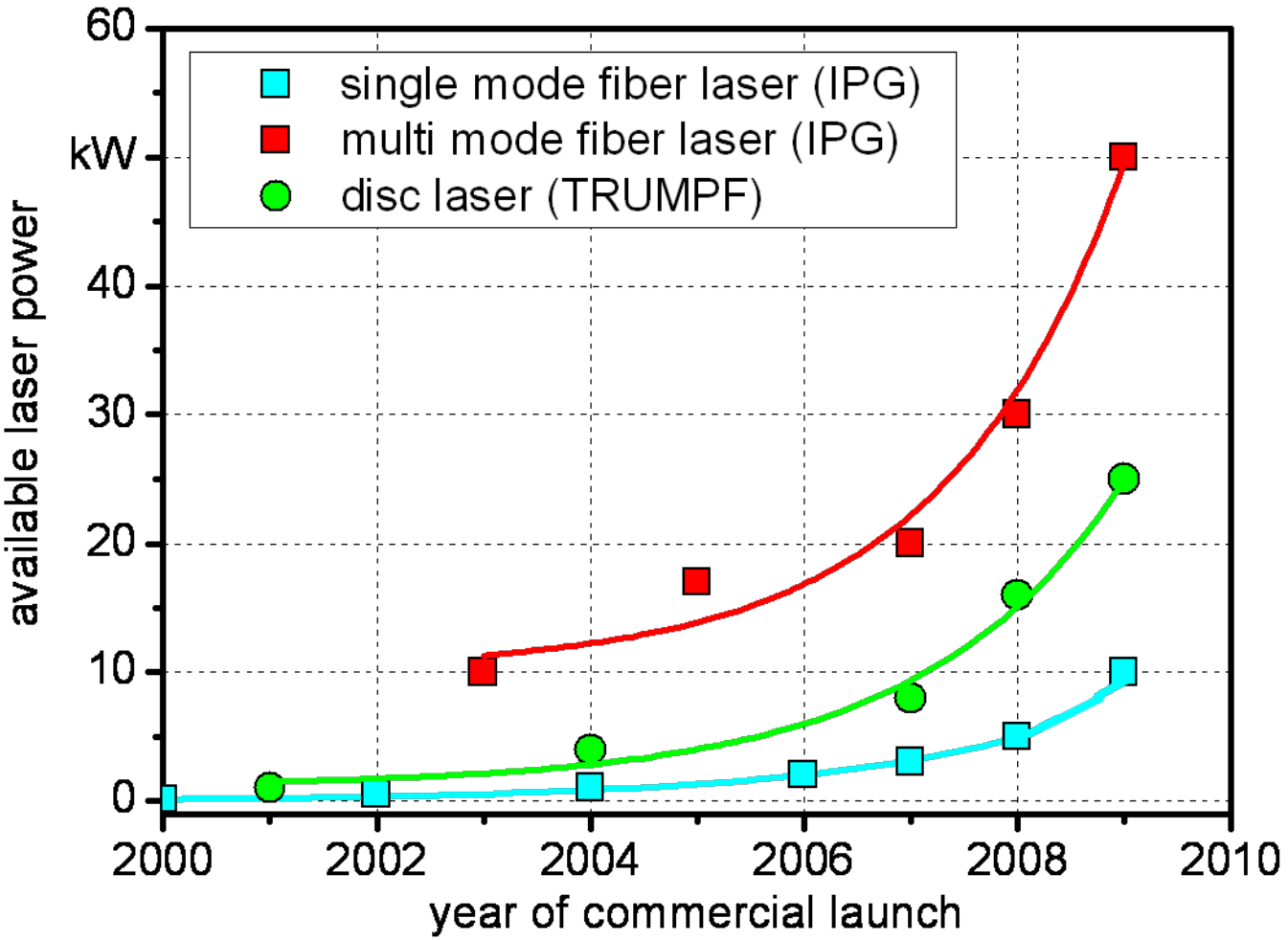




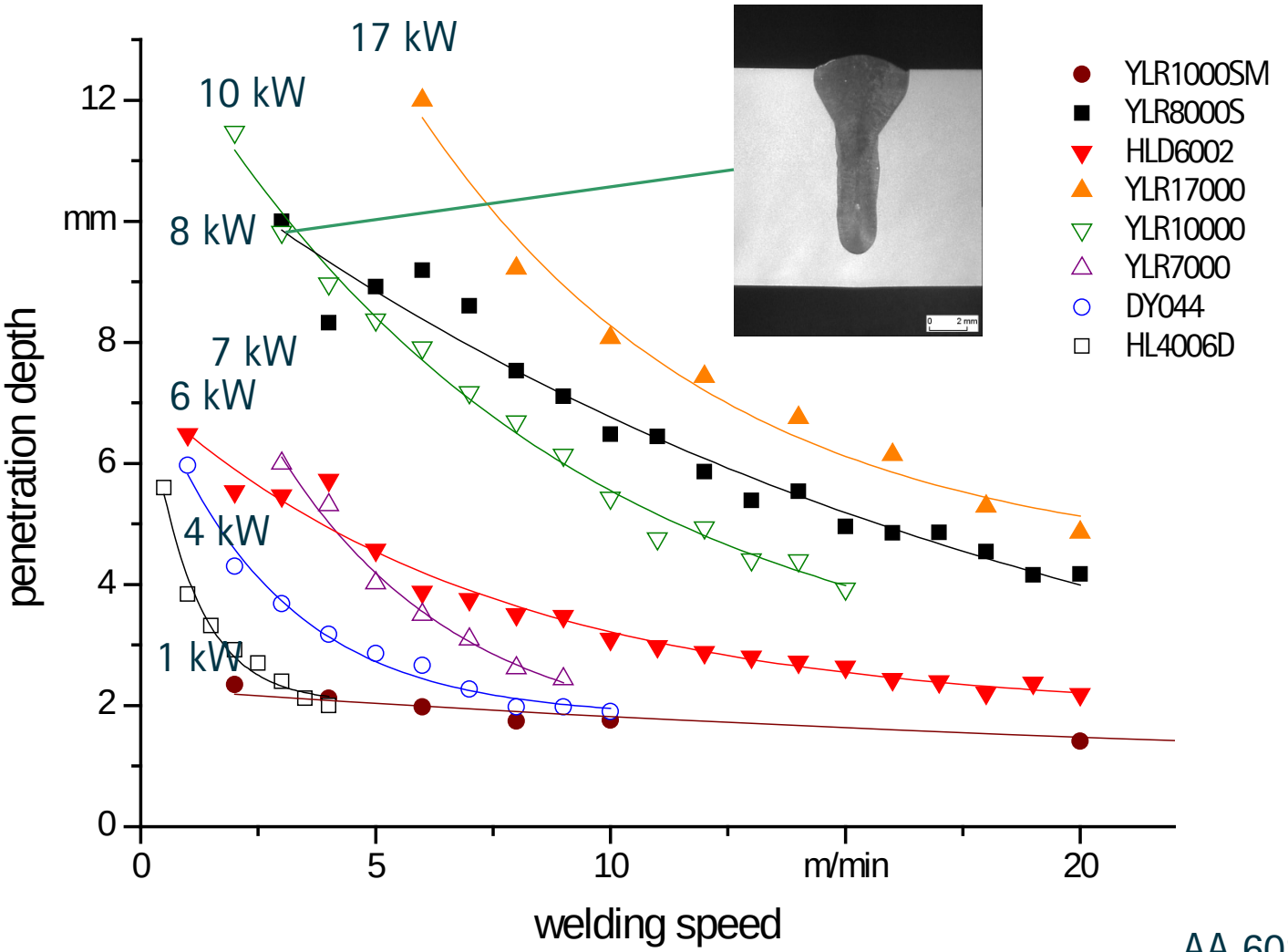
High Brightness Multi Mode Lasers for Welding

Source: Trumpf, IPG

Development of commercial high power lasers

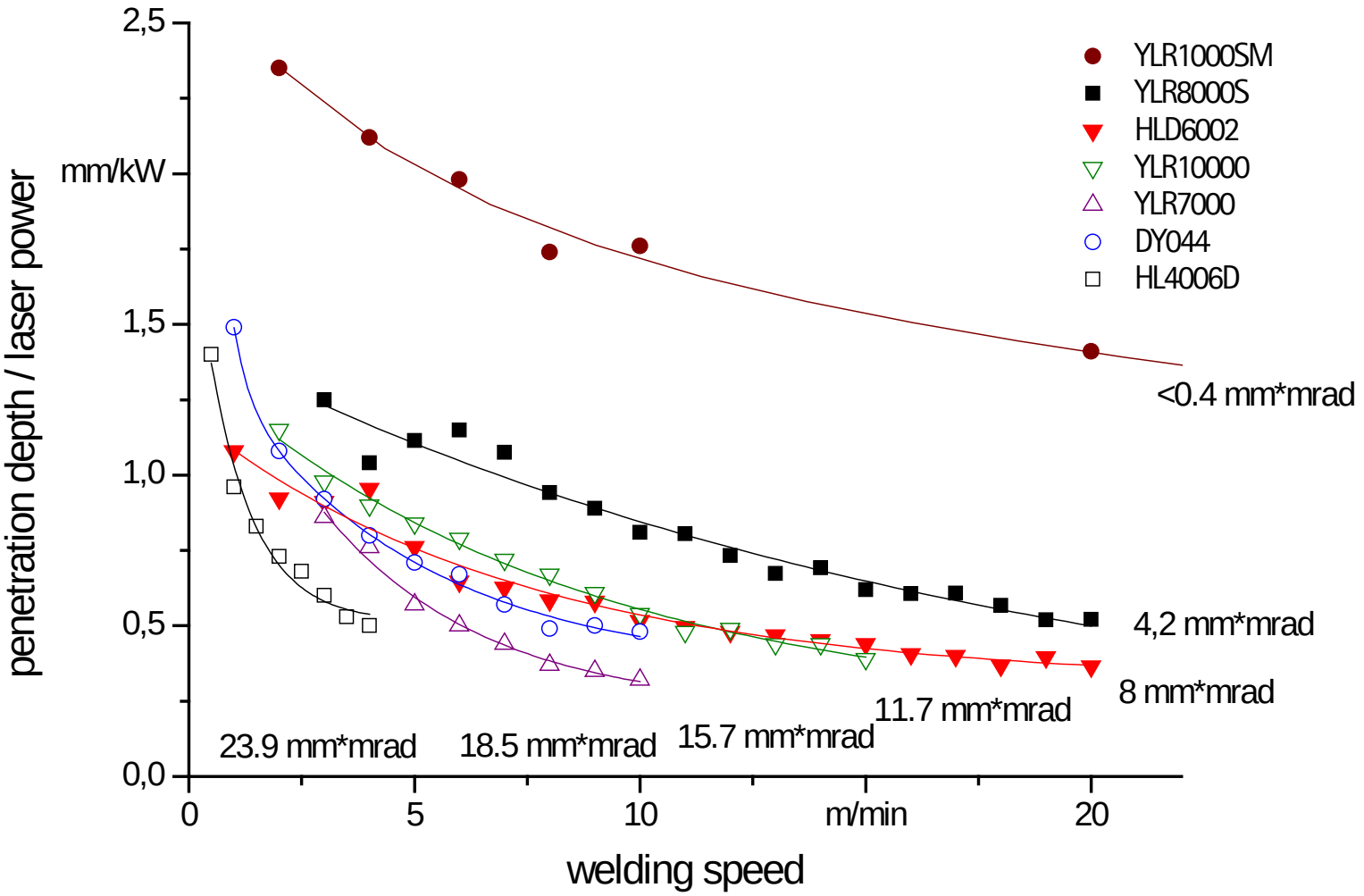


Penetration of various Solid State Lasers



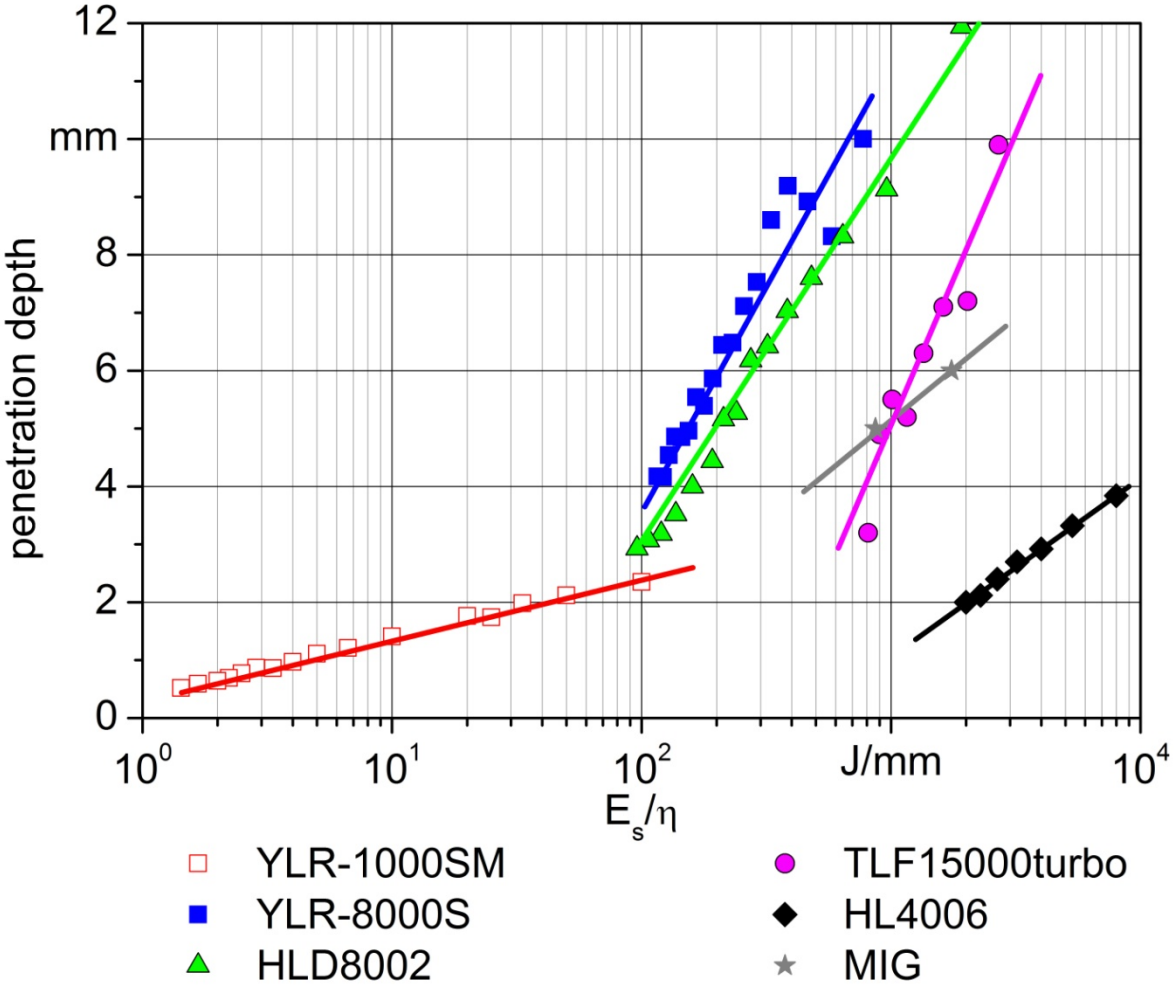
AA 6082

Penetration of various Solid State Lasers



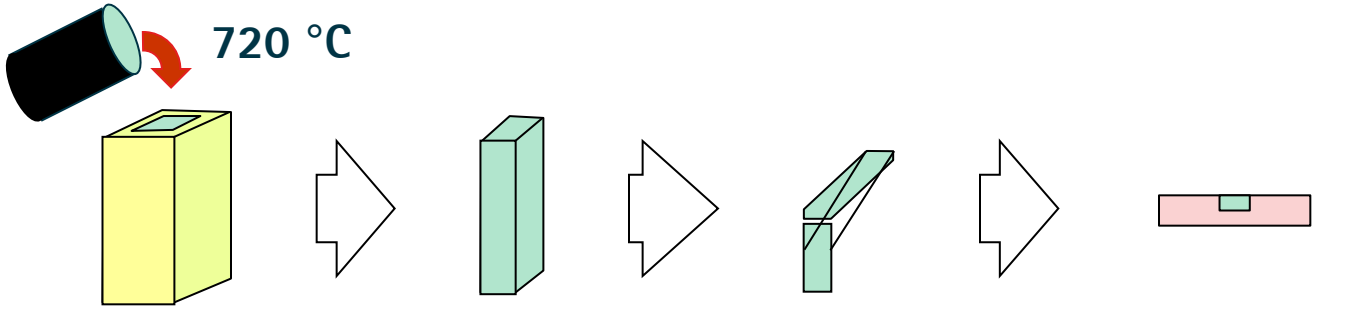
AA 6082

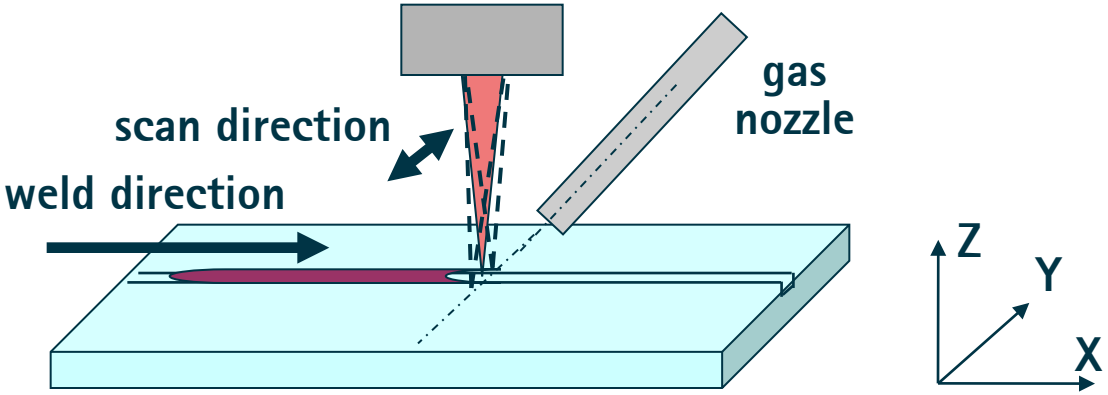
Effective energy consumption for welding



AA 6082

Controlled amount of grain refiner



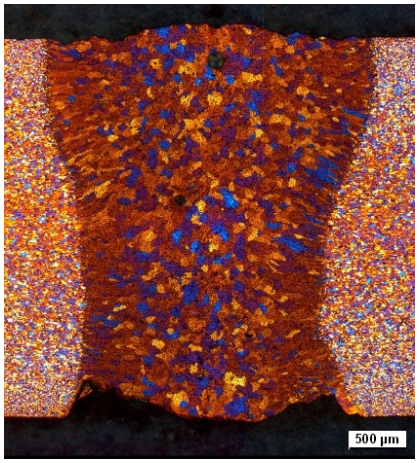


laser welding of sheets with insert

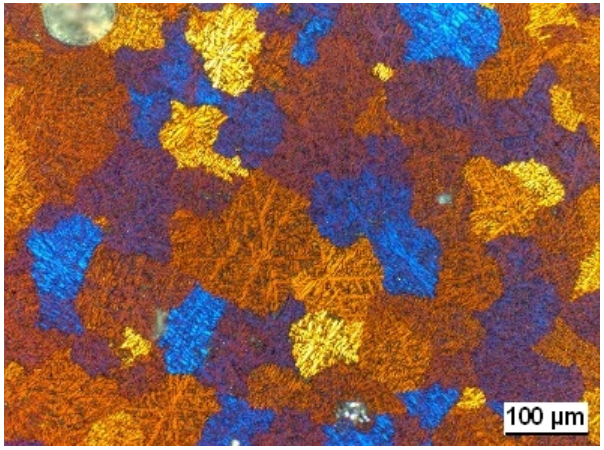
beam source	**8 kW disc laser**	**master alloy**	**Al-5Ti-1B**
base material	**AA 5083**	**insert cross section**	**2 x 1.5 mm²**

BIAS ID 110294

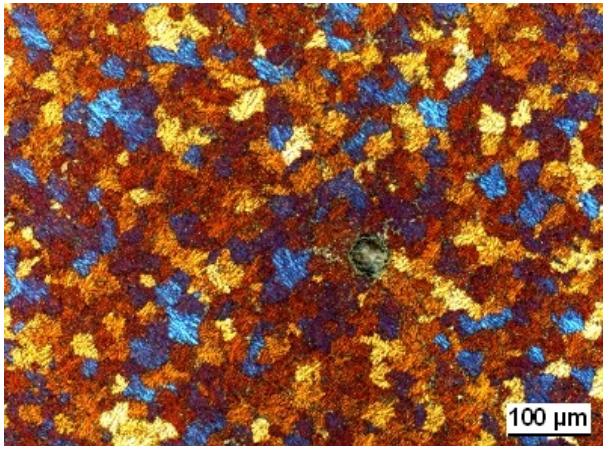
Grain structure



~0.03% Ti in the weld



~0.26% Ti in the weld

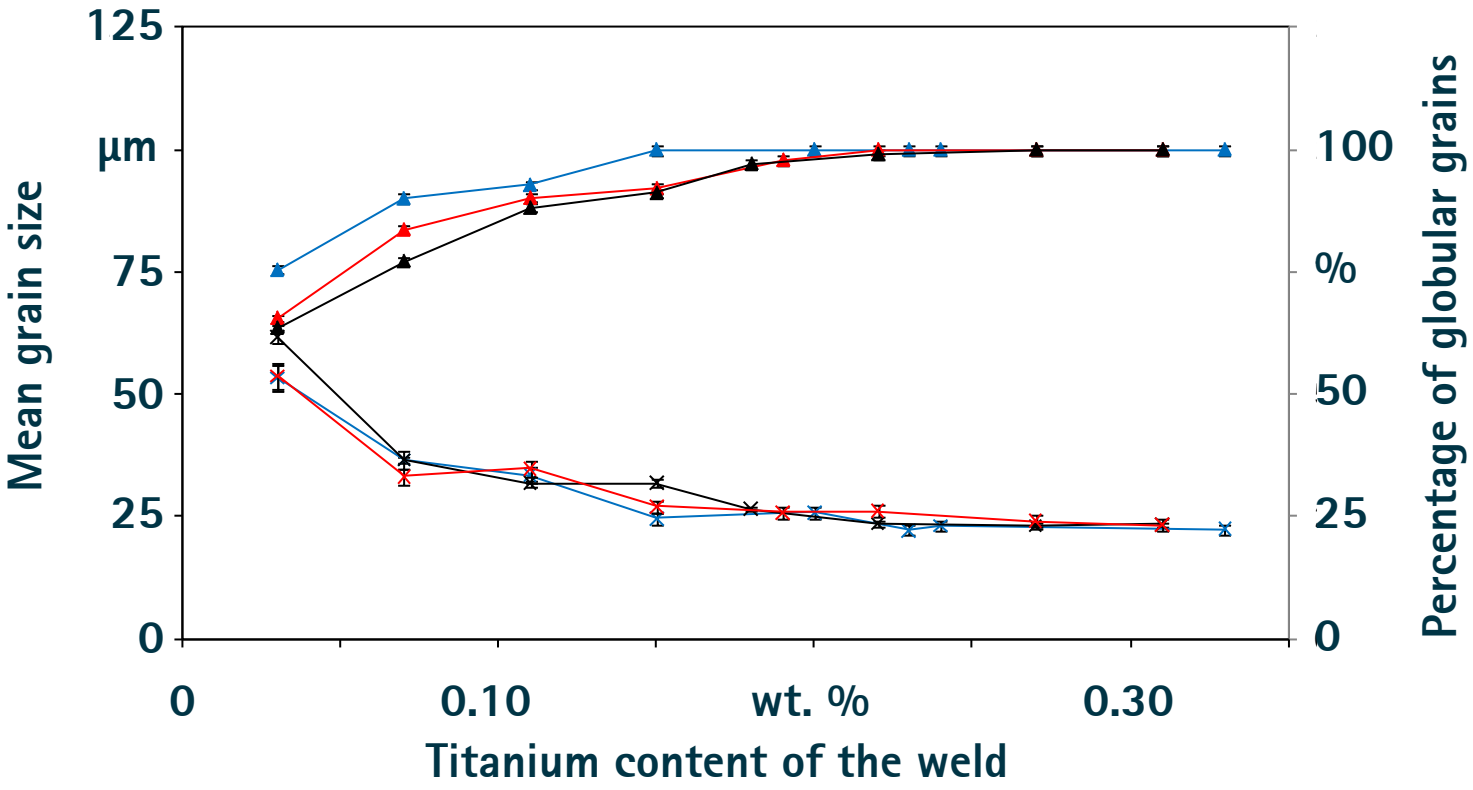


P = 6 kW; v = 4 m/min

Base Material: Al Mg4.5Mn0.7 (AW-5083)

Full grain refinement (complete equiaxed grains)

Influence of the Titanium content



mean grain size:

- v = 2 m/min P = 3.5 kW
- v = 4 m/min P = 6 kW
- v = 6 m/min P = 8 kW

Percentage of globular grains

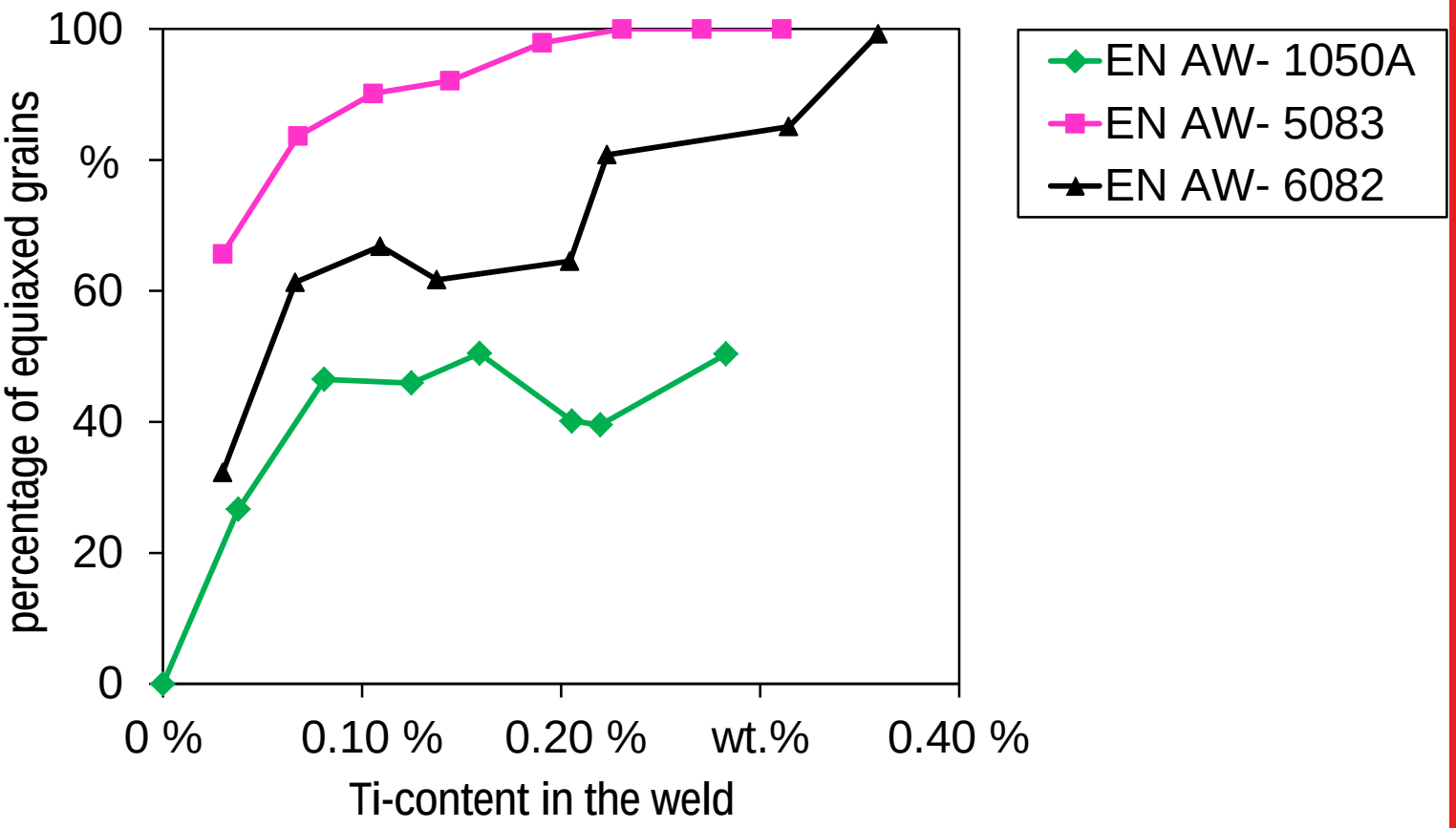
- v = 2 m/min P = 3.5 kW
- v = 4 m/min P = 6 kW
- v = 6 m/min P = 8 kW

beam source 8 kW disc laser

base material AA 5083

BIAS ID 110296

Influence of Ti/B-addition on grain form

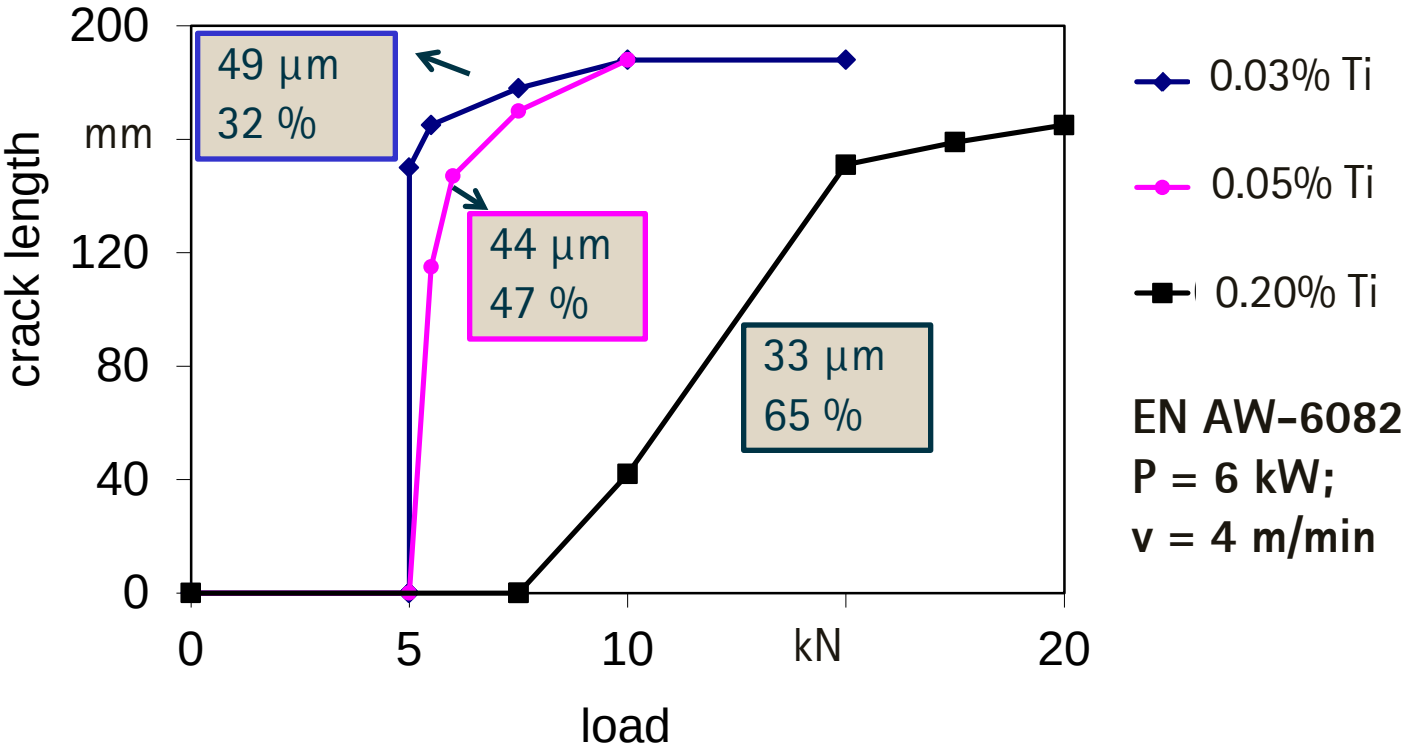


Laser: P = 6 kW, v = 4 m/min;
TIG: U = 11.2 V, I = 175 A, v = 0.252 m/min

Great influence of the alloys on the grain form.

BIAS ID 111515

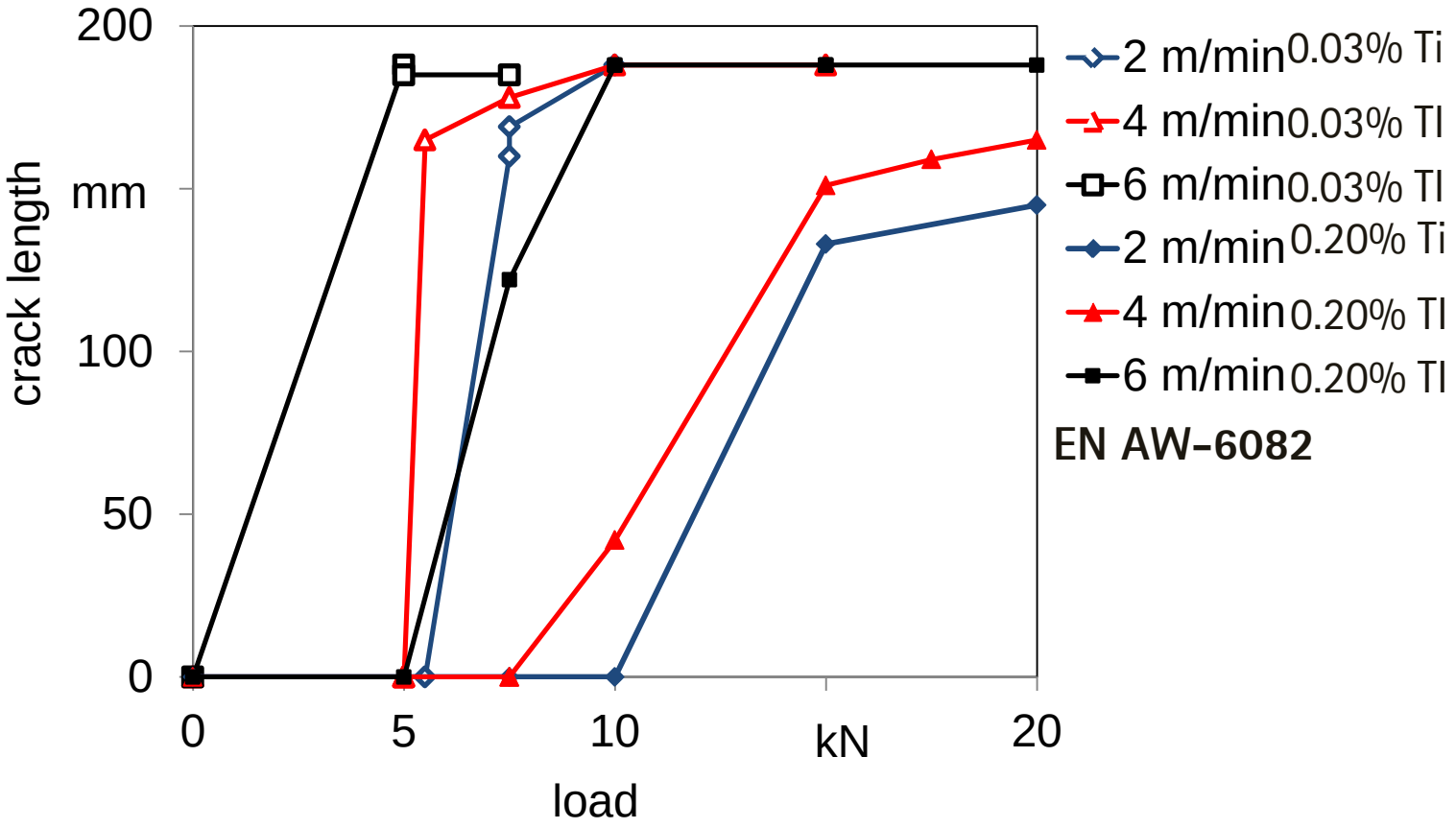
Hot cracking test – DELTA test



Influence of grain refinement on hot cracking susceptability.

BIAS ID 111519

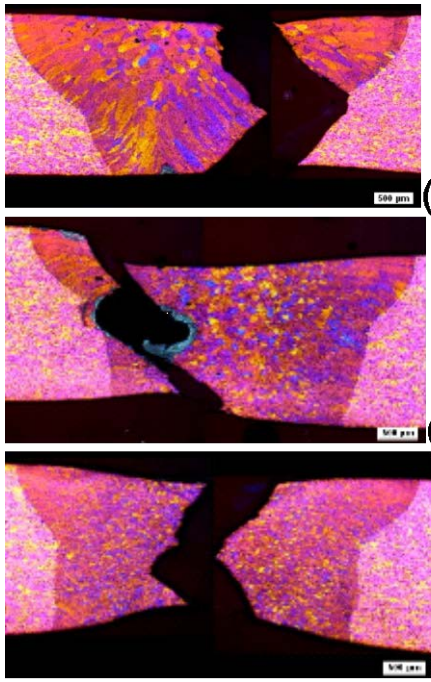
Hot cracking test – DELTA test



Influence of welding parameter on hot cracking susceptability.

BIAS ID 111520

Tensile test (DIN EN 895)

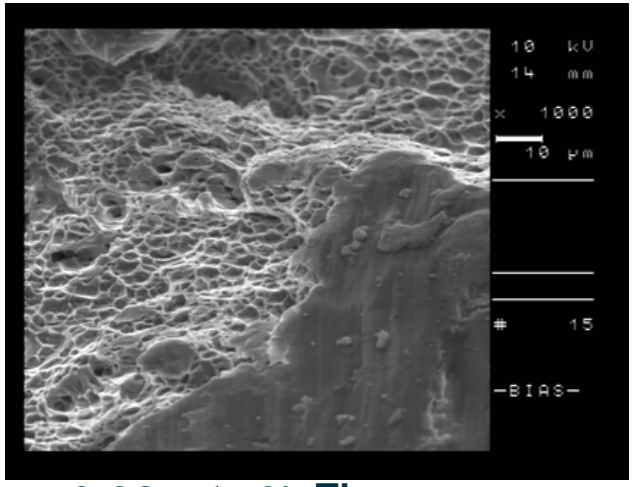


(a) 0.03 wt.-% Ti

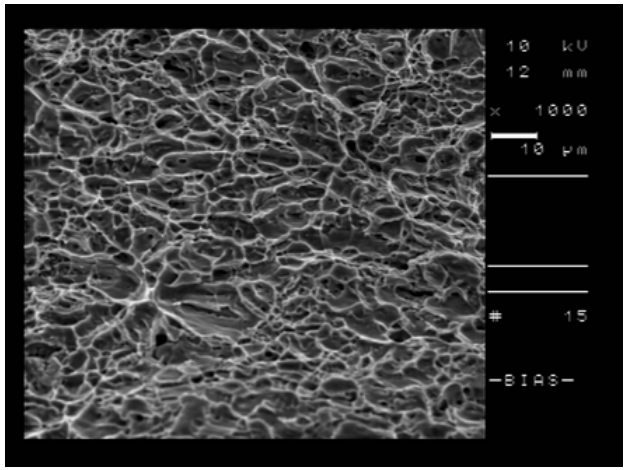
(b) 0.07 wt.-% Ti

(c) 0.37 wt.-% Ti

EN AW-6082
P = 6 kW;
v = 4 m/min;
L_0 = 10 mm



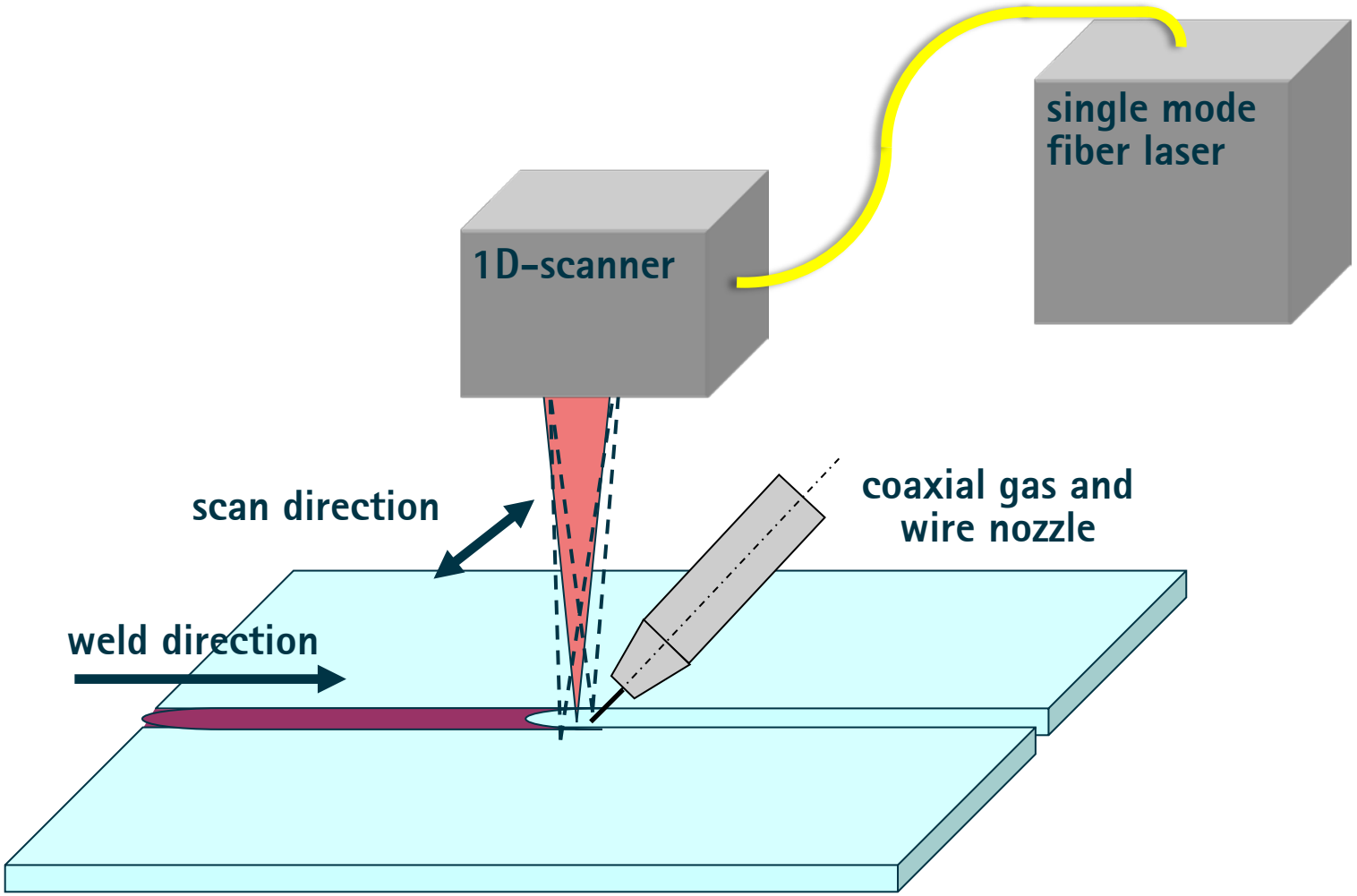
0.03 wt.-% Ti



0.37 wt.-% Ti

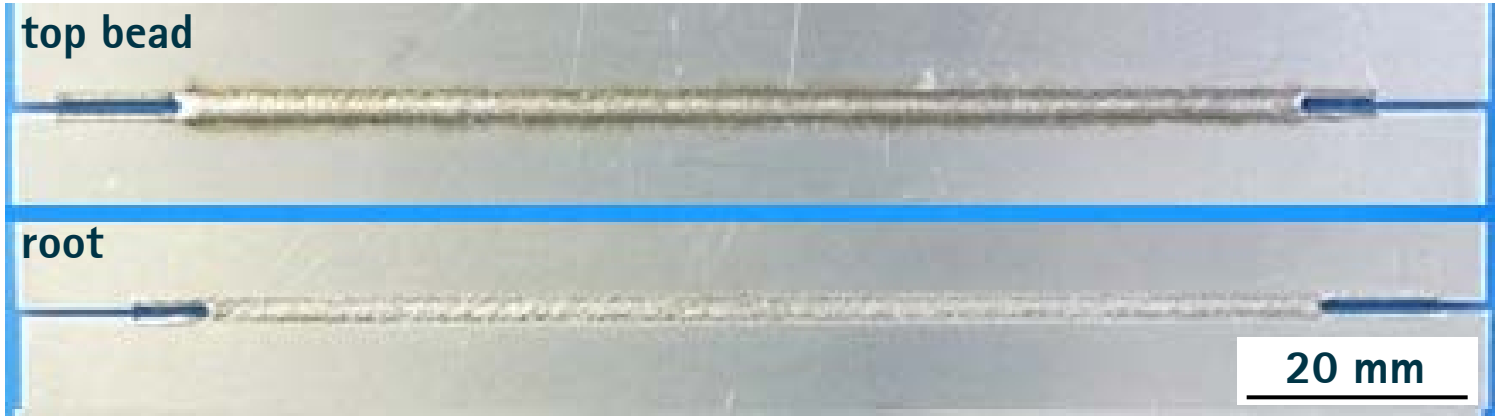
BIAS ID 111522

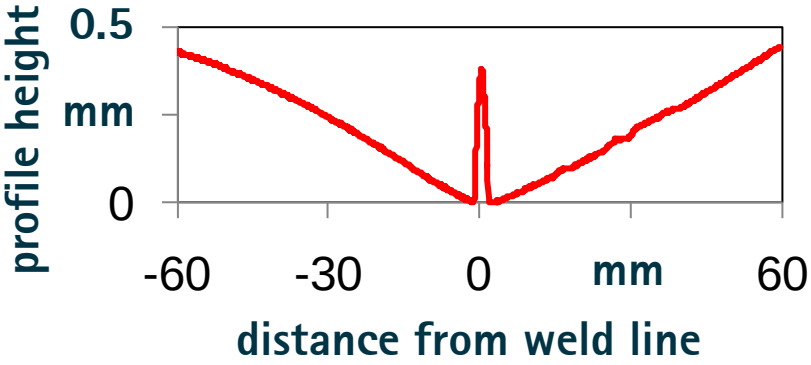
Low distortion thin sheet welding with gap

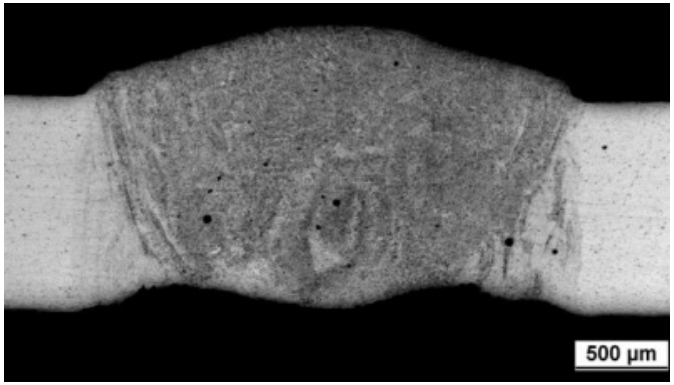


BIAS ID 110507

Low distortion thin sheet welding with gap





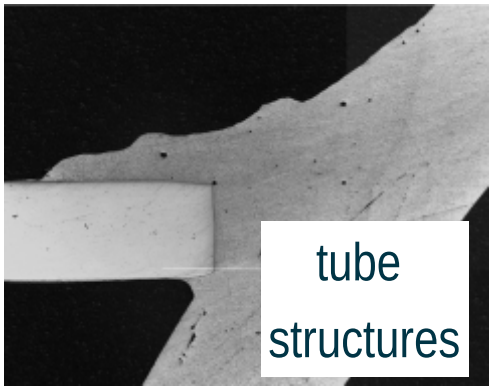


beam source	1 kW sm fiber laser	laser power	1 kW
base material	AA 6082	welding speed	2 m/min
filler wire	AlSi 5	wire feed rate	3 m/min

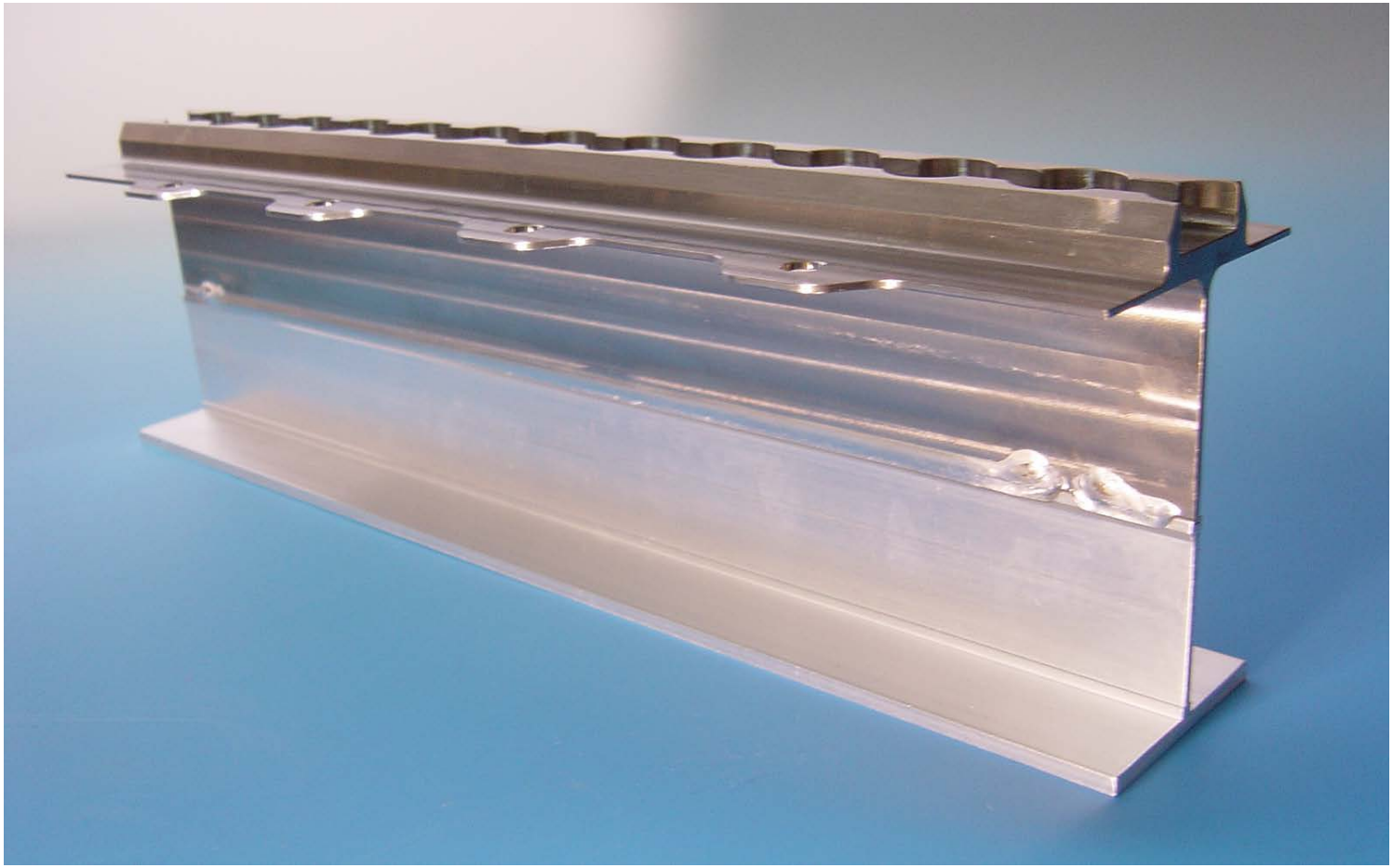
BIAS ID 110303

Aluminum–Steel Welding

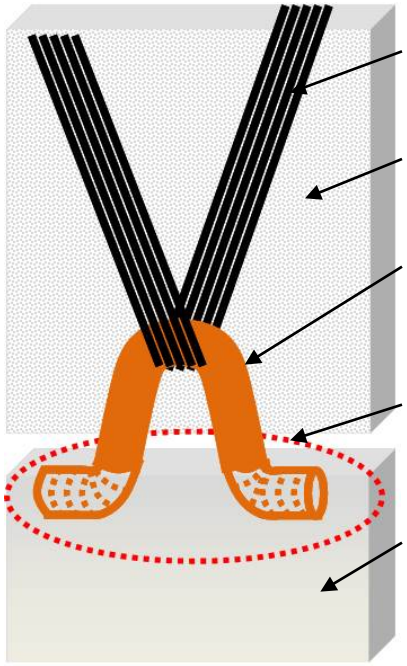
BIAS, LFT

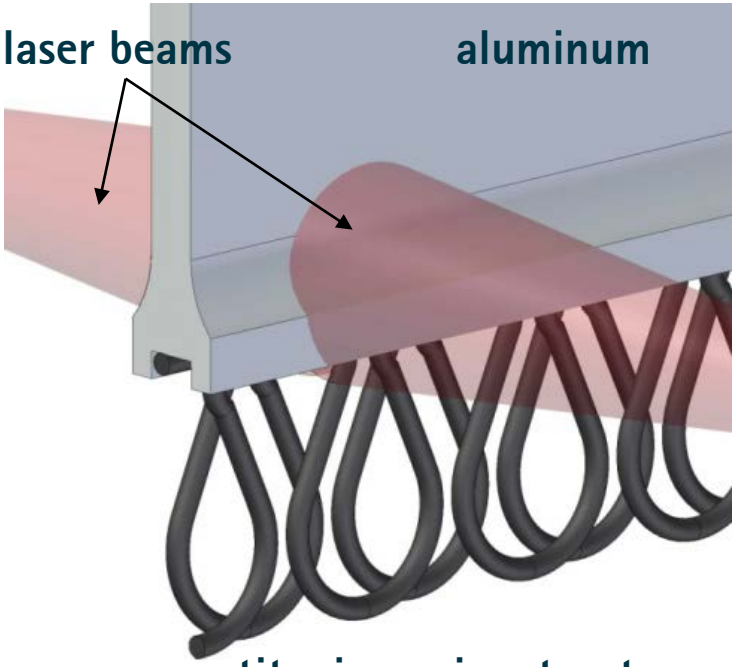


Aluminum-Titanium Aircraft Component



Design approach for Al-Ti-CFRP joint



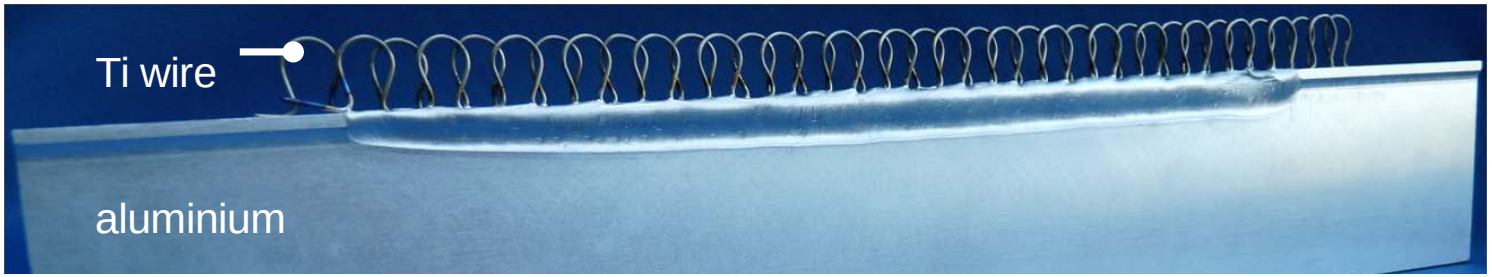


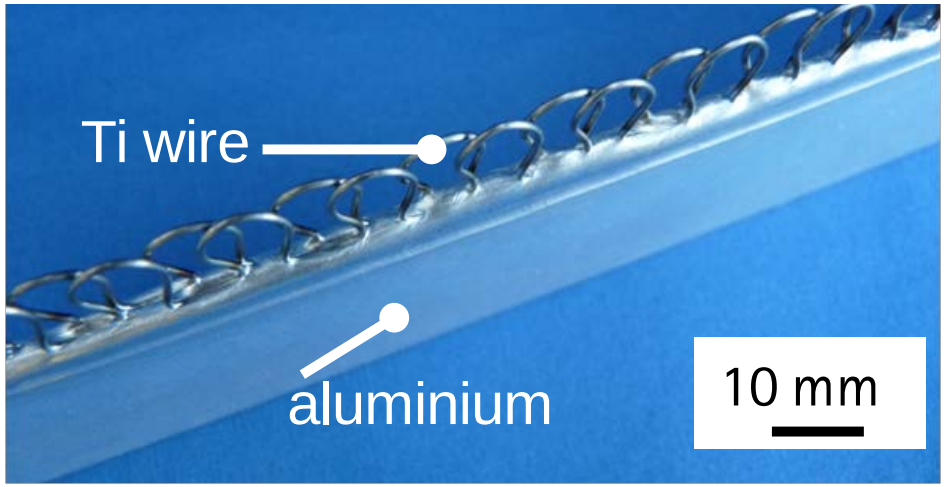
titanium wire structure

aluminum alloy	AA 6056	fiber type	HTS 5631 24k
titanium wire alloy	Grade 2 (pure)	filament diameter	7 µm
titanium wire diameter	0.8 mm	matrix material	2-comp. epoxy

BIAS ID 110304

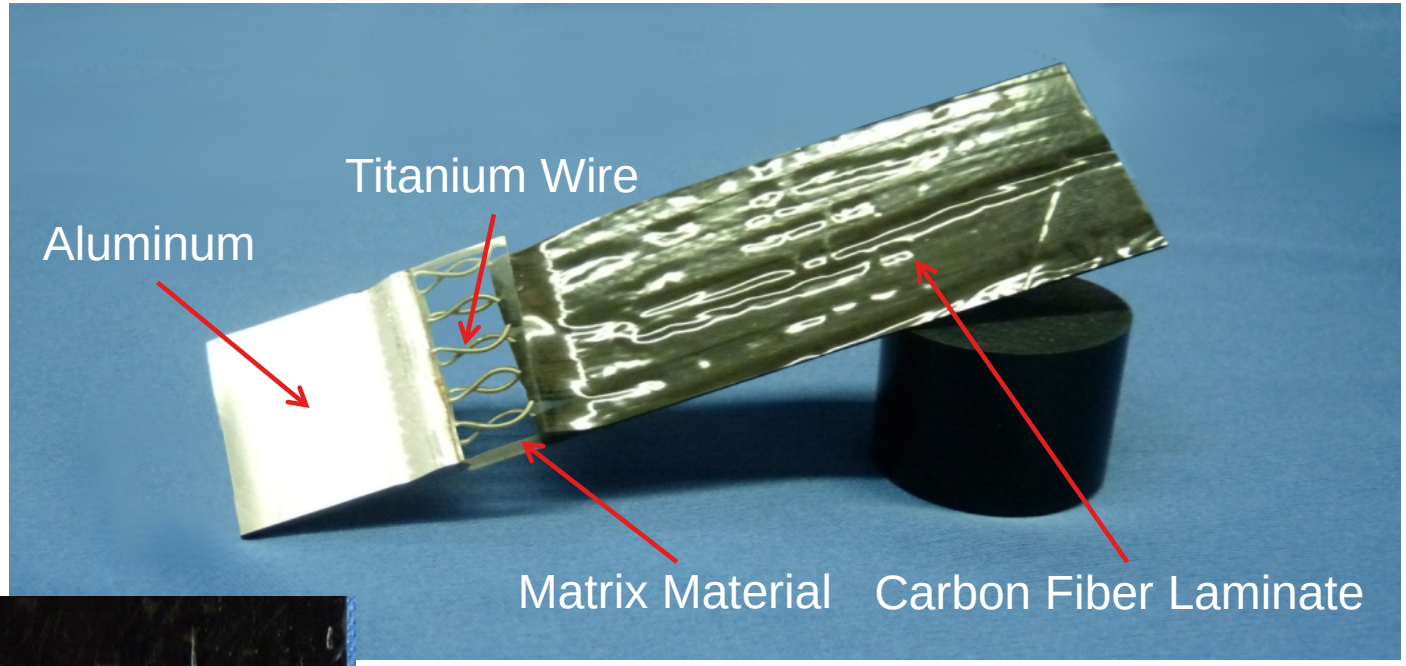
Welded specimen



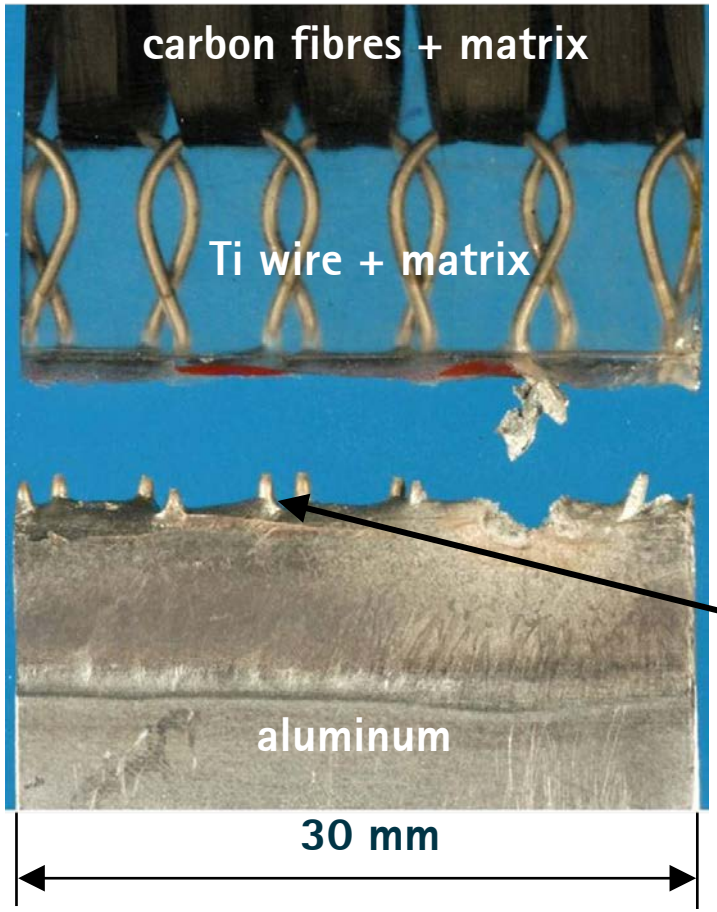


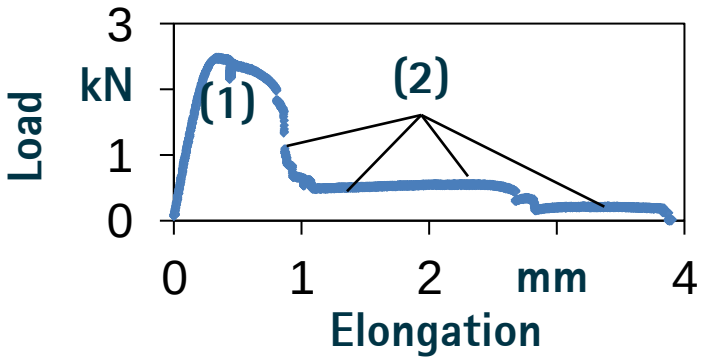
beam source	4 kW Ip Nd:YAG	titanium wire diameter	0.8 mm
aluminum alloy	AA 6056	laser power	2 x 1.4 kW
titanium wire alloy	Grade 2 (pure)	joining speed	0.22 m/min

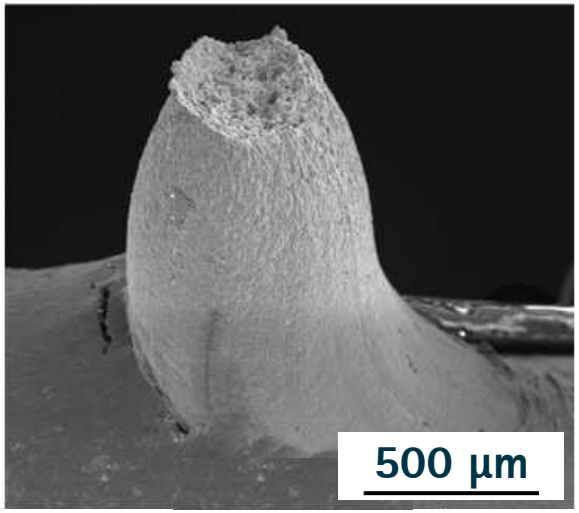
Aluminium-CFRP Joint



Tensile testing







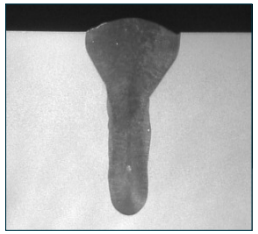
beam source	4 kW lp Nd:YAG	titanium wire diameter	0.8 mm
aluminum alloy	AA 6056	laser power	2 x 1.4 kW
titanium wire alloy	Grade 2 (pure)	joining speed	0.22 m/min

BIAS ID 110307

Conclusions

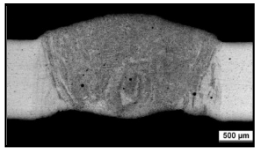
Examples of current research of the Center of Competence for Welding of Aluminum Alloys – Centr-Al have been presented:

- High brightness lasers offer previously unattained laser power and beam quality, allowing for highly efficient welding processes with faster welding speed, deeper penetration and slender welds with low heat input and low distortion.



- Weldability can be significantly increased by using grain refinement. These results are intended for a fast transfer into application by the companies involved in the projects.

- Gap and distortion can be addressed when using a highly focused laser beam with scanner. Application oriented R&D on this topic is just starting.

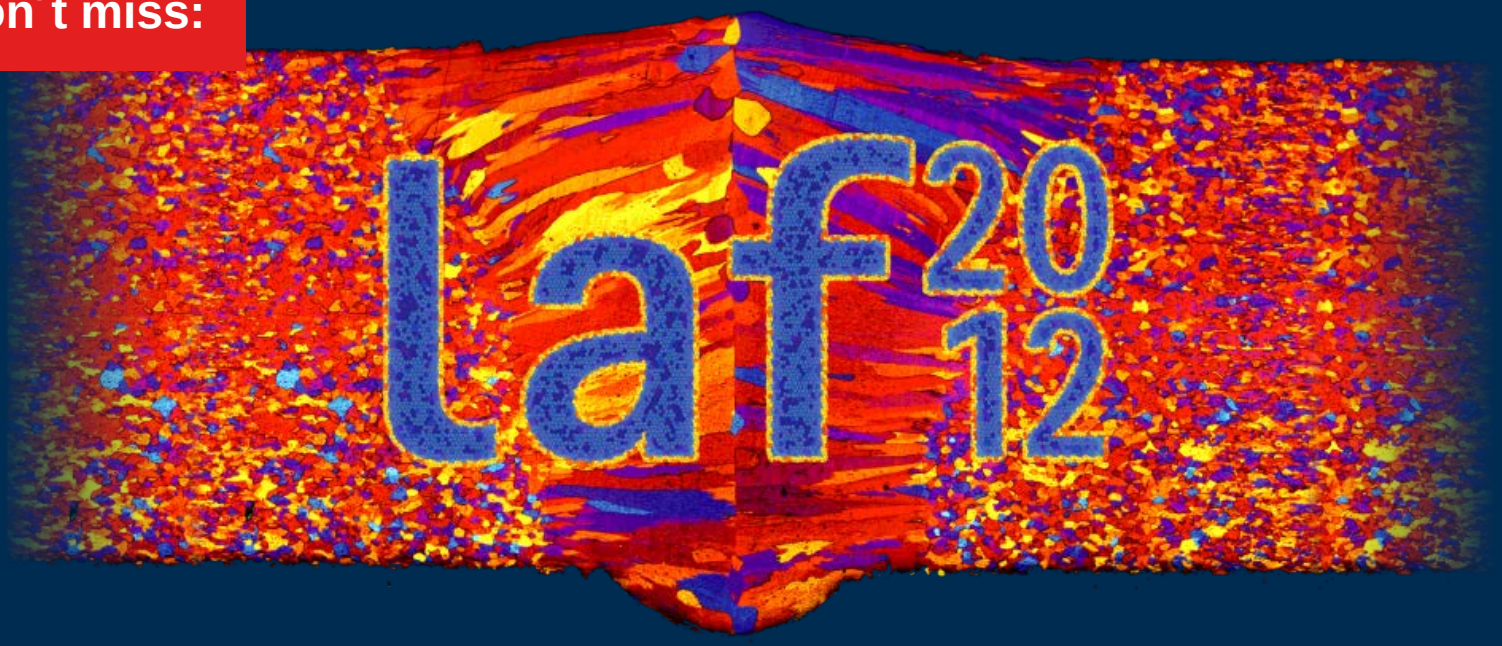


- A new design concept for joining aluminum and CFRP was introduced that is promising with respect to size, weight and corrosion of such joints. Fundamantal research has started on this topic.

Thank you for your attention!

bias
Bremer Institut für
angewandte Strahltechnik GmbH

Don´t miss:



Schwerpunkt Qualitätssicherung

8. Laser-Anwenderforum

12.–13. September 2012 · Park Hotel Bremen

www.das-schweisst-zusammen.de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