ICTM PARTNER COMMUNITY 2017 & COLLABORATIVE R&D 2017

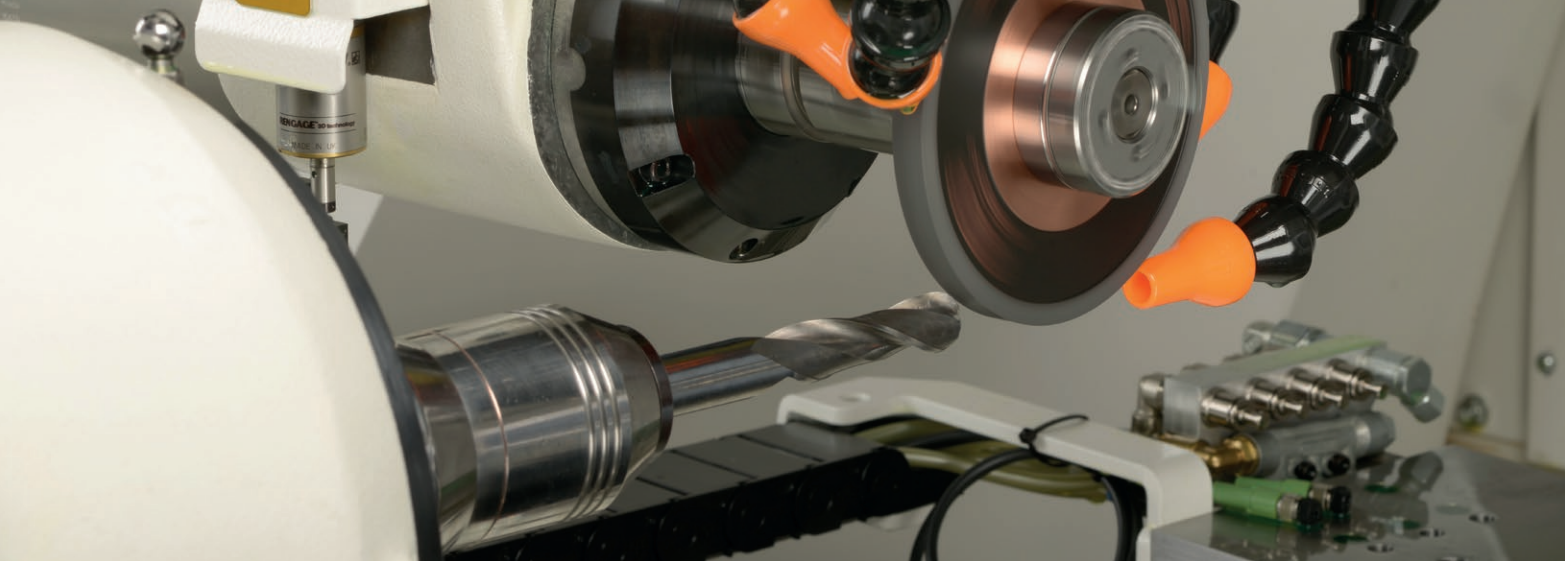
The ICTM Partner Community is the workgroup of industry partners and R&D institutions of the ICTM Aachen focussing on Collaborative R&D Projects in the fields of Advanced Machining, Additive Manufacturing and Industrie 4.0. All Collaborative R&D projects are defined and conducted on an annual base integrating all partners to input their particular demands and participate in the results. These projects allow high synergies and significant benefits of cooperation in particular for precompetitive issues.

Based on the fixed annual contributions of each of the ICTM Industry Partners a set of ten projects is conducted in 2017. All results of the Collaborative R&D projects will be presented in line with the two day Annual R&D Meeting in November for all members in Aachen. Furthermore, the Collaborative R&D Projects for the year 2018 will then be selected by the ICTM Partner Community.

The 29 participating Industry Partners as well as as short descriptions of the ten conducted Collaborative R&D projects in 2017 are presented in the following.

ICTM Industry Partners

– ABB Turbo Systems Ltd
– BCT Steuerungs- und DV-Systeme GmbH
– Blaser Swisslube AG
– BorgWarner Turbo Systems GmbH
– Carl Zeiss Industrielle Messtechnik GmbH
– DMG Mori AG
– EMAG ECM GmbH
– Extramet AG
– GF Machining Solutions Agie Charmilles SA
– GKN Aerospace
– HAMUEL Maschinenbau GmbH & Co. KG
– Honeywell Aerospace
– IHI Corporation
– KUKA Industries Reis GmbH & Co. KG Maschinenfabrik
– Makino Milling Machine Co. Ltd.
– MAN Diesel & Turbo SE
– Marposs S.p.A.
– MBFZ toolcraft GmbH
– Mitsubishi Heavy Industries Ltd
– Mitsubishi Hitachi Tool Engineering, Ltd.
– MTU Aero Engines AG
– Oerlikon Metco AG
– Pietro Rosa TBM
– Rolls-Royce Deutschland Ltd & Co KG
– Siemens AG
– SLM Solutions GmbH
– Starrag AG
– Walter AG
– Yamazaki Mazak U.K. Limited



ADVANCED MACHINING

Further Investigations on Process Chains for Blisk Manufacturing

Which potential can be achieved in identified process chains for blisk-manufacturing (nickel-based alloys)?

- Nickel-based alloys require case based performance analysis to derive best-suited manufacturing process chains for particular features
- Manufacturing of blisk geometries with regard to roughing and semi-finishing processes
- Manufacturing of a demonstrator for each process chain
- Economical assessment

Improve Machining of γ-TiAl

How can the machining processes of Titanium aluminides be improved?

- Milling
  - Identification of cooling lubrication strategies for improving tool life and surface quality
  - Development of cutting tool material and/or coating system for increasing tool life
- EDM/ECM
  - Identification of suitable machining parameters for EDM/ECM processes including achievable tolerances

CMC Machining

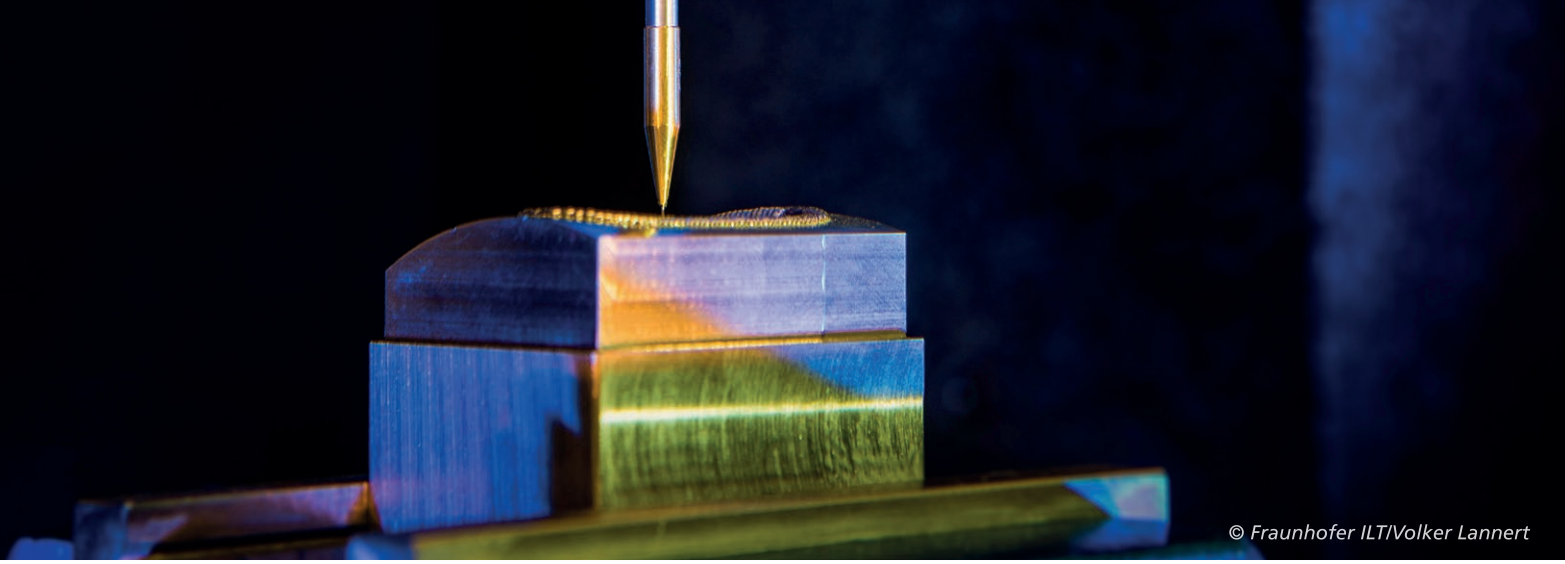
What are the most suitable technologies and applicable parameters to trim SiC/SiC?

- SiC/SiC will become more relevant for the hot section of turbomachinery in the future
- Suitability/efficiency of possible machining technologies is unknown
- Comparison of different machining technologies (milling/grinding & EDM) by experimental analysis
- Technological and economical benchmark
- Identification of potentials for optimization

Characterization of Regrinded Cutting Tools

To what extent does the cutting tool performance decrease within the tool life cycle when milling nickel-based alloys?

- Extensive tool wear in machining of new and advanced nickel-based alloys leads to high tool costs
- With several regrinding operations, a loss of performance of the cutting tools can be observed
- Evaluation of a possible performance loss of cutting tools in milling Inconel® 718 due to several regrinding operations
- Identification of possible causes for performance loss



ADDITIVE MANUFACTURING

Wire-based LMD for Repair and AM Applications

Is a coaxial wire feeding LMD head suited for repair and AM applications?

– Compared to powder additives, wire additives offer advantages such as: high material efficiency, reduced contamination of the deposited material and machine, fewer health & safety hazards
– Set-up of wire-based LMD
– Assessment of wire deposited layers (metallurgical evaluation)
– Evaluation of economical and technical aspects based on gathered data

3D Additive Manufacturing with LMD – Robot-based vs. Cartesian Machine

What are the limits for 3D-AM with LMD when using a robot-based or cartesian machine system?

– Using robot-based systems for additive manufacturing with LMD may offer economic advantages and more flexibility
– Effects on final part accuracy and difference in achievable geometries unknown
– Compare cartesian and robot-based systems in regard to achievable part geometries
– Process know-how
– Machine park for testing

Influence of Powder Properties on Processability and Part Properties in SLM

What are key powder properties influencing part quality in SLM?

– Typical nickel-based superalloy powders for SLM are produced by gas atomization and have a chemical composition close to the one used in casting or forging
– Although powder quality is a key aspect to achieve a high part quality, the key powder properties are still not clear and not standardized
– Acquisition and analysis of different powders for SLM
– Manufacturing and analysis of samples
– Adaptation of developed procedure for identification of key powder properties for the SLM process

Quality and Design Possibilities for typical Features in Turbomachinery Parts

What is the best way to manufacture e.g. thin walled blades with internal cooling features?

– Manufacturing of prototypes (non-AM-design e.g. for casting) or parts (AM-design) by SLM
– Reduced shape and dimensional accuracy of critical features (e.g. hot gas path) due to local distortion
– Blocked cooling system or increased surface roughness due to supports and their removal

Capabilities of X-Ray CT for NDT of SLM Parts

What are the capabilities of X-Ray CT for defect detection in "standard" AM Parts?

– Characteristic size and shape of defects in parts manufactured by SLM in comparison to casted or wrought parts
– Measuring resolution ("Voxel-Size") of CT is limited by part dimensions, material and selected measuring setup
– Resolution and failure detection capability for typical SLM (inner) structures (channels, walls) not evaluated
– IManufacturing of test parts with typical features of turbomachinery parts and measurement of integrated (internal) structures and its characteristic defects by CT
– Comparison of CT-scans with cross sections. Benchmark for applicability of NDT by X-Ray CT on the AM-Process quality assurance

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Or follow www.ictm-aachen.com to receive additional information regarding the ICTM Collaborative R&D Projects.

INDUSTRIE 4.0

Process Data Acquisition and Cloud-based Management

How to acquire process data and manage it in a decentralized system?

– During machining operations, data from different data sources can be acquired
– A flexible data acquisition solution and management system is needed for advanced analysis and visualization technology
– Development of a integrative data acquisition and a cloud-based management solution