Neues Denken. Neue Materialien.

INM COLLOQUIUM

"ADDITIVE MANUFACTURING, 3D PRINTING, POROSITY AND SYNCHROTRON EXPERIMENTS"

Prof. Dr. Anthony Rollett
Carnegie Mellon Universität, Pittsburgh, USA

Tuesday, June 11, 2019, 11:00 am

INM, Leibniz-Saal, Campus D2 5
Host: Prof. Dr. Eduard Arzt

3D printing of metals has advanced rapidly in the past decade and is used across a wide range of industry. Many aspects of the technology are considered to be well understood in the sense that validated computer simulations are available. At the microscopic scale, however, more work is required to quantify and understand defect structures, which affect fatigue resistance, for example. Synchrotron-based 3D X-ray computed microtomography (µXCT) was performed at the Advanced Photon Source on a variety of AM samples using both laser (SLM) and electron beam (EBM) powder bed; this showed systematic trends in porosity. Optical and SEM characterization of powders used in additively manufacturing (AM) reveals a variety of morphologies and size distributions. Computer vision (CV), as a subset of machine learning, has been successfully applied to classify different microstructures, including powders. The power of CV is further demonstrated by application to detecting and classifying defects in the spreading in powder bed machines, where the defects often correspond to deficiencies in the printed part. In addition to the printed material, a wide range of powders were measured and invariably exhibited porosity to varying degrees. Outside of incomplete melting and keyholing, porosity in printed parts is inherited from pores or bubbles in the powder. This explanation is reinforced by evidence from simulation and from dynamic x-ray radiography (DXR), also conducted at the APS. DXR has revealed a wide range of phenomena, including void entrapment (from powder particles), keyholes (i.e., vapor holes) and hot cracking. Keyhole depth is linearly related to the excess power over a vaporization threshold. One key conclusion is that power density can be more important than the more commonly used energy density. Concurrent diffraction provides information on solidification and phase transformation in, e.g., Ti-6Al-4V and stainless steel. High Energy (x-ray) Diffraction Microscopy (HEDM) experiments are also described that provide data on 3D microstructure and local elastic strain in 3D printed materials, including Ti-6Al-4V and Ti-7Al.

Neues Denken. Neue Materialien.

INM

SHORT BIO

I have been a member of the faculty at Carnegie Mellon University since 1995. I am also the Co-Director of the newly formed NextManufacturing Center on additive manufacturing. Previously, I worked for the University of California at the Los Alamos National Laboratory. I spent ten years in management with five years as a Group Leader (and then Deputy Division Director) at Los Alamos, followed by five years as Department Head at CMU (up to 2000). I have been a Fellow of ASM since 1996, Fellow of the Institute of Physics (UK) since 2004 and was chosen to be a Fellow of TMS in 2011. I received the Cyril Stanley Smith Award from TMS in 2014, was elected as Member of Honor by the French Metallurgical Society in 2015 and then became the US Steel Professor of Metallurgical Engineering and Materials Science in 2017. My research group has about ten students and is supported by AFOSR, DOE/BES, DOE/EERE, DOE/ARPA-E, NASA, PITA, Boeing, NextM and Northrop-Grumman. The focus of my research is on additive manufacturing, the measurement and prediction of microstructural evolution, the relationship between microstructure and properties, with a particular emphasis on three-dimensional effects, texture & anisotropy and the use of synchrotron x-rays.

You are invited to have coffee with the speaker 15 minutes before the talk starts.

KONTAKT

INM – Leibniz-Institut
für Neue Materialien gGmbH
Campus D2 2
66123 Saarbrücken
www.leibniz-inm.de

Christine Hartmann
Event Manager
christine.hartmann@leibniz-inm.de
Tel: 0681-9300-244
Fax: 0681-9300-233