Technical University of Munich
TUM School of Engineering and Design
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The Fascination of the Microstructures of Additively Manufactured Materials

Creative Contrasting Methods using Etching, Optics and Filters

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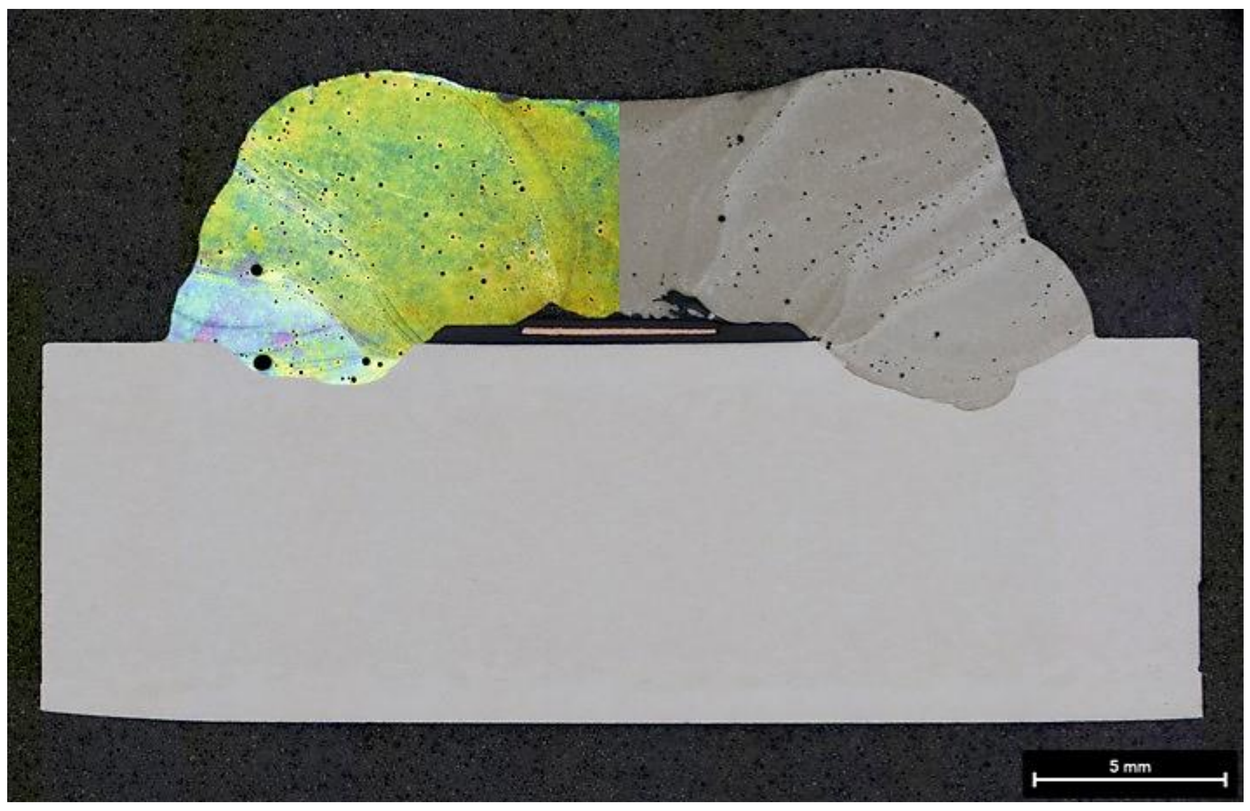
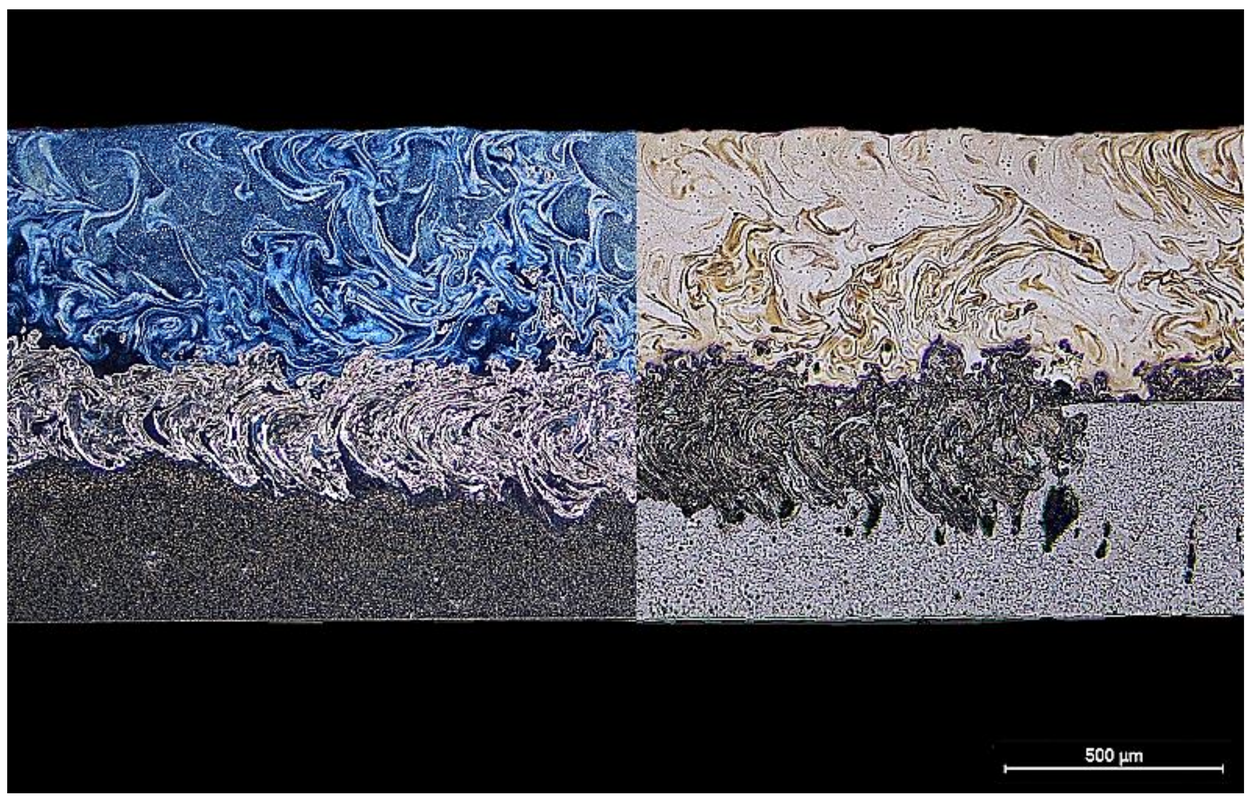
Additive manufacturing (AM) enables unprecedented control over material architecture, yet it also introduces complex and often unique microstructures. These microstructures, shaped by rapid solidification, thermal gradients, and layer-wise processing, present both challenges and opportunities for characterization. This work explores the visualization of AM microstructures through creative contrasting techniques, combining selective etching, advanced optical light microscopy, and digital filtering. By enhancing phase boundaries and morphological features, these methods reveal the intricate beauty and underlying metallurgy of additively manufactured metals.

[1]



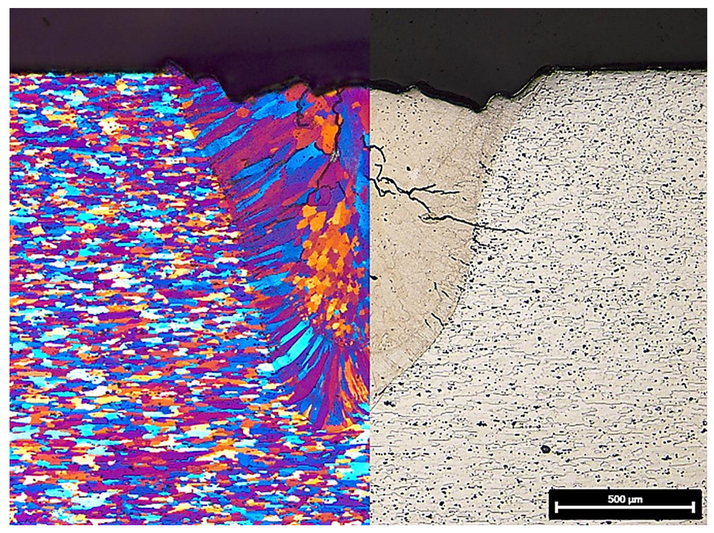
Process: Wire arc additive manufacturing (EN ISO/ ASTM 52900)
Material: Aluminum EN AW-5183 on EN AW-6060-substrate, cross section
Etching: Triple-etching: 10 % NaOH/ Klemm II/ KMnO4-NaOH solution vs. Kroll
Microscopy: Brightfield

[2]



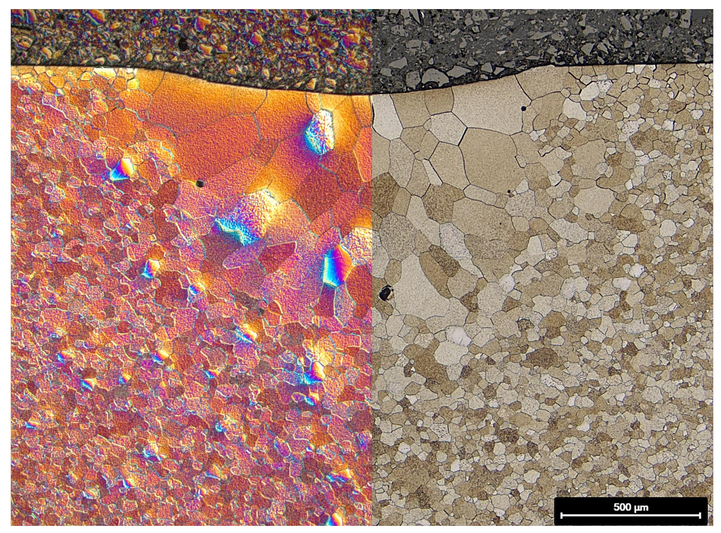
Process: Laser-welding (EN ISO 4063: Process 52)
Material: Aluminum EN AW-1050, longitudinal section
Etching: Kroll
Microscopy: Darkfield vs. Brightfield

[3]



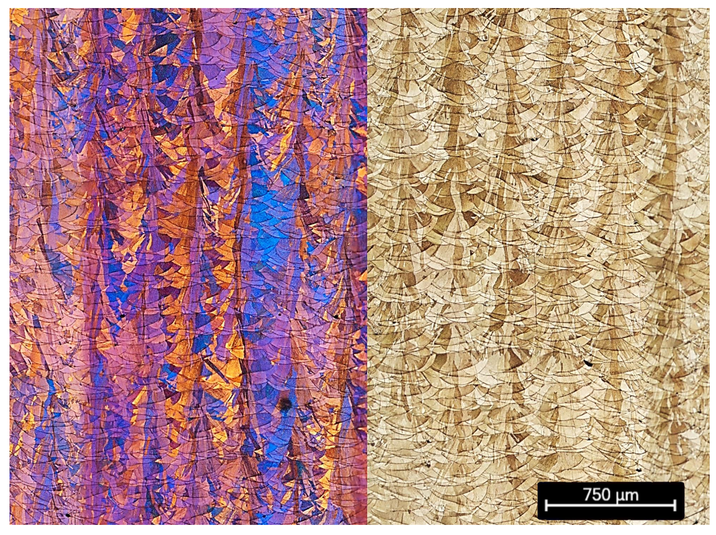
Process: Laser beam shaping – single weld track (EN ISO 13694 and EN ISO 11146)
Material: Aluminum EN AA-6013, cross section
Etching: Barker (electrolytical)
Microscopy: Polarized Light vs. Brightfield

[4]



Process: Laser beam shaping – single weld track (EN ISO 13694 and EN ISO 11146)
Material:Tungsten 99,95 %, cross section
Etching: Murakami
Microscopy: Differential interference contrast vs. Brightfield

[5]



Process: Laser-based powder bed fusion of metals (EN ISO ASTM 52911/ ASTM 52904)
Material: Steel 316L (1.4404), cross section
Etching: V2A stain/ 90 °C
Microscopy: Polarized Light vs. Brightfield

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References
[1]: Dr. Josip Vincic, Postdoctoral Researcher, Division Lead for Sustainability at Bavaria Makes Garching, Chair of Materials Engineering of Additive Manufacturing, TUM School of Engineering and Design, Technical University of Munich
[2]: M.Sc. Michael Kick, Institute for Machine Tools and Industrial Management , TUM School of Engineering and Design, Technical University of Munich
[3] [4]: Dr.-Ing. Thomas Stoll, Chair of Materials for Additive Manufacturing, Institute of Materials Science, University of the Federal Armed Forces Munich
[5]: M.Sc. Jan Reimann, Chair for Laser-based Additive Manufacturing, TUM School of Engineering and Design, Technical University of Munich