In situ metal alloying by Direct Metal Deposition

Thorsten Kramer,
Marco Fasel, Matthias Steck, Dr. Hossein Najafi, Prof. Dr. Valerio Romano

Institute for Applied Laser, Photonics and Surface Technologies ALPS
Photonics in Industrial Production

Introduction

Process Principle

Quelle: Fraunhofer ILT

Quelle: TWI
Introduction

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Local Metallurgy

Rapid Alloy Development

In-situ Alloy Formation

LDMD

Rapid Prototyping

3D printing

Additive Manufacturing

Powder Blending

Alloy bulk compositions

Intrinsic Heat Treatment

Rapid Manufacturing

Laser Cladding

Gradient Materials

Chemical composition

Microstructures

Properties

Rapid Prototyping
Introduction

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- Fiberlaser
- Layered Workpiece
- Positioning System
- Working Head
- Laser Control
- Motion Control
- Powder Feeder
- Processing Gases
Introduction

Conventional ODS Production

Matrix

Oxide

Mechanical Alloying

Hot Compaction

Subtractive Shaping

Product

Laser Additive Manufacturing

Matrix

Oxide

Powder Mixing

Laser Additive Manufacturing

Finishing

Product
Introduction

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Conventional Route
- Mechanical Alloying
  - ~48 h

Adapted Route
- Ball Milling
  - ~4 h

New Route
- Laser Synthesis Processing
  - ~1 h

Time for Mixing

Flowability of Powder
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Introduction

Scalmalloy®

- Aluminium-Magnesium-Scandium-Legierung
- Dichte 2,67 g/cm³
- Zugfestigkeit 520 Mpa
- Bruchdehnung 13%
Rapid Alloying by LDMD

Idea | In-Situ Metal Alloying

- Generation of alloy composition by adjusting powder ratio of Aluminum and Nickel during LDMD process

- Gradient Materials

- Adaption to
  - base plate material
  - part geometry
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Rapid Alloying by LDMD

Objectives

- Phase Diagramme
  Nickel-Aluminum
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Nickel-Powder CNPC-Ni 100-300

Grain Diameter | µm

Frequency

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Aluminum-Powder 60 HPS

Grain Diameter | µm

Frequency

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Aluminum-Powder Toyo Aluminum K.K. A1070-80BB
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Experimental Setup

Fiberlaser
IPG Photonics YLS-2000

Fiber 300 µm

Powder Feeder
GTV PF 2/2

Working Head
Trumpf BEO50
with Powder Nozzle

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Preliminary Results AlNi$_3$
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Preliminary Results AlNi$_3$
«A laser is a solution seeking a problem.»

T.H. Maiman
Rapid Alloying by LDMD

Providing Solutions

Define Specification and Characteristics locally
- Density
- Yield Strength
- Ductility
- Microstructure
- Gradient according to requirements

- design product
- define specification
- create product
«To make an end is to make a beginning.»
T.S. Eliot

thorsten.kramer@bfh.ch