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RUHR UNIVERSITÄT BOCHUM RUB

Solid solution strengthening

in TiZrNbHfTa High Entropy Alloys

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LAT
Laseranwendungstechnik

<u>Priority programme</u>

Compositionnaly complex alloys – High Entropy alloys (CCA – HEA)

SPP 2006/1, 04.04.2017, Bayreuth University

Motivation – State of the art

Basic-scientific understanding of solid solution strengthening (mechanical properties) in BCC High entropy alloys

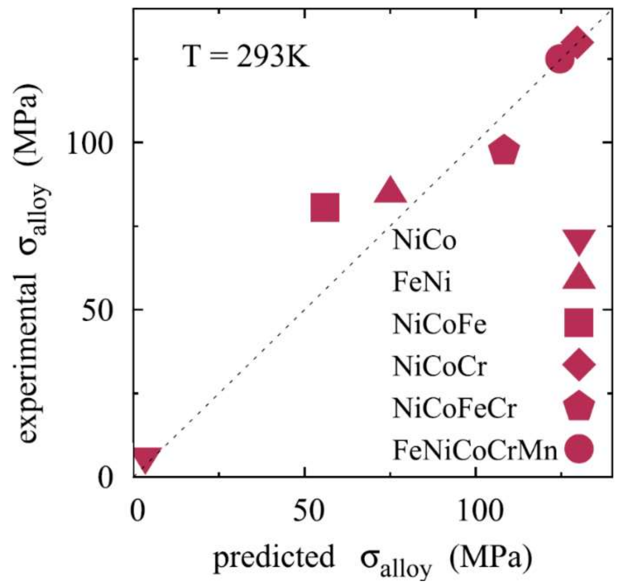
Models of solid solution strengthening:

$$\frac{d\tau_0}{dc} = f\left(\frac{1}{a}\frac{da}{dc}, \frac{1}{G}\frac{dG}{dc}\right)$$

1) diluted solid solutions -> **Fleischer**
2) concentrated solid solutions -> **Labusch**
3) **New theory** for **FCC** HEAs and MEAs

C. **Varvenne** et al., Acta Mater. 118 (2016) 164-176

Solid solution strengthening in BCC HEAs cannot be explained by current textbook-level theory



Objectives and work plan

Screening

Processing of **graded** TiZrNbHfTa alloys by LMD

Microstructural and phase analyses

CLAT

Comparison LMD / bulk alloys

Basic scientific understanding of solid solution strenghtening in BCC HEAs

Correlation: $$\frac{\mathrm{d}\tau_0}{\mathrm{d}c} = f\left(\frac{1}{a}\frac{\mathrm{d}a}{\mathrm{d}c}, \frac{1}{G}\frac{\mathrm{d}G}{\mathrm{d}c}\right)$$

Upscaling

Processing of **bulk** alloys with promising chemical compositions

Tensile tests

Identification of **Basic deformation mechanisms**

LWW

Preliminary work – Laser Metal Deposition

Advantages

-> fast screening of chemical compositions

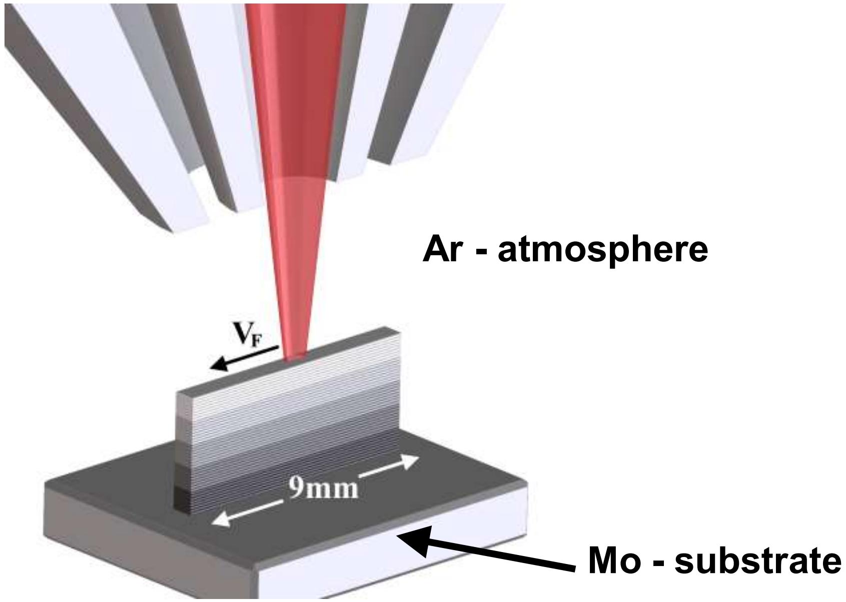
-> relatively large sample sizes allow
to assess bulk material properties

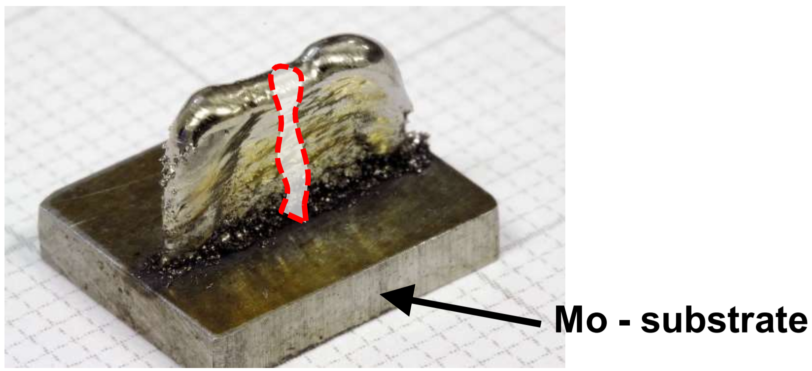
Local characterization of

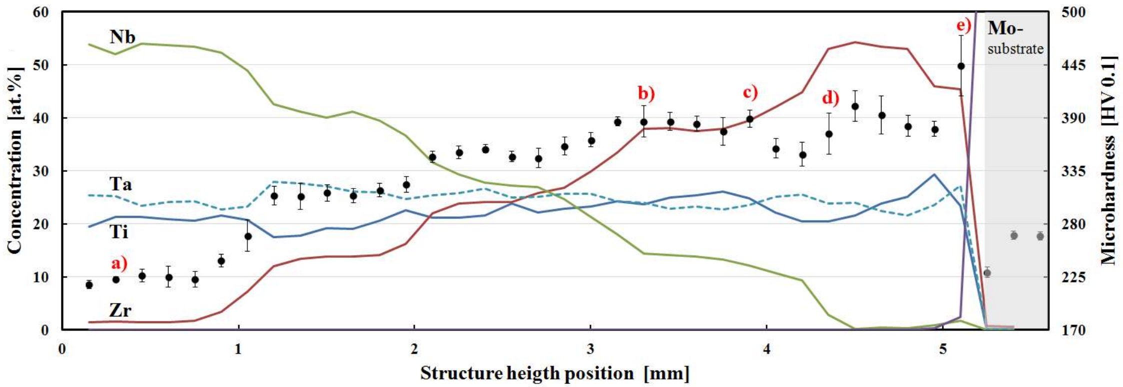
-> mechanical properties

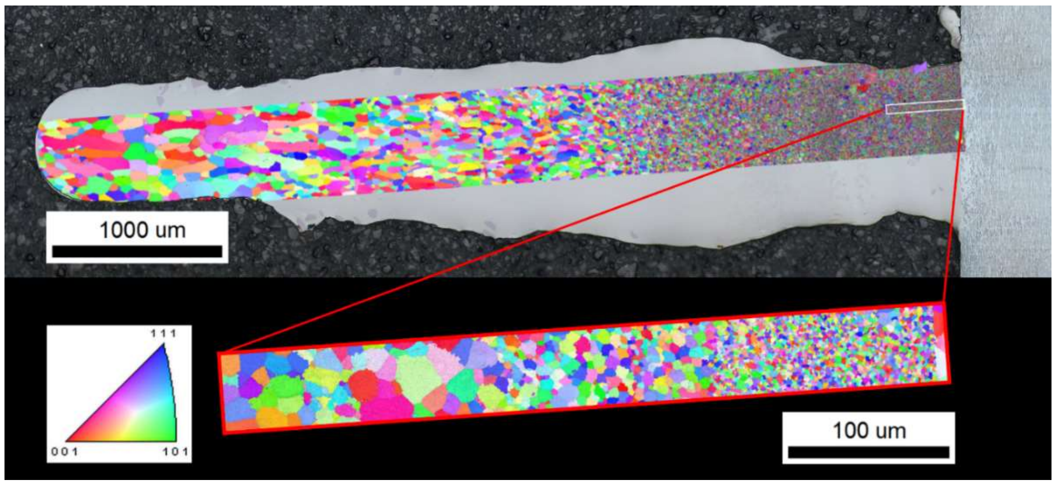
-> phases (single phase BCC)

-> grain size gradient (3 – 200 µm)
Hall-Petch effect

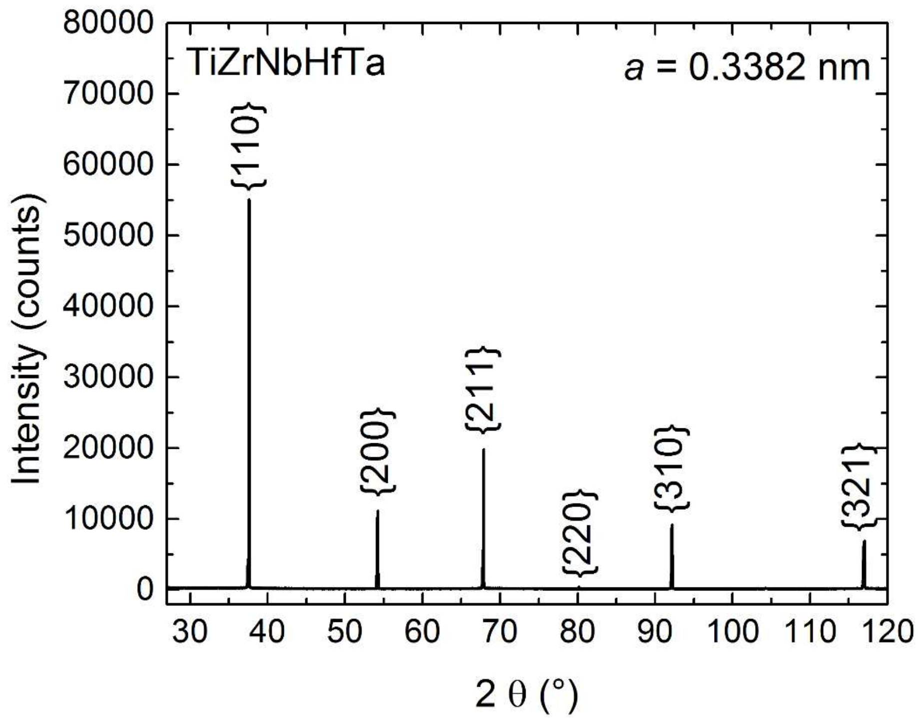


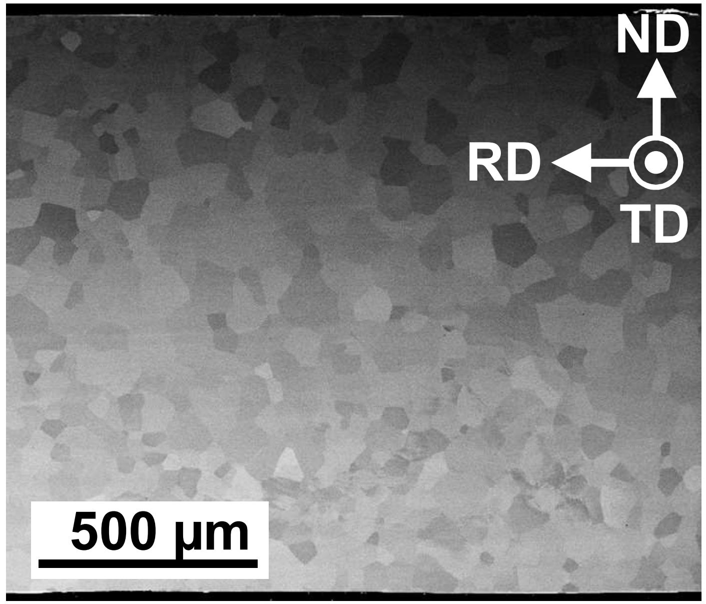


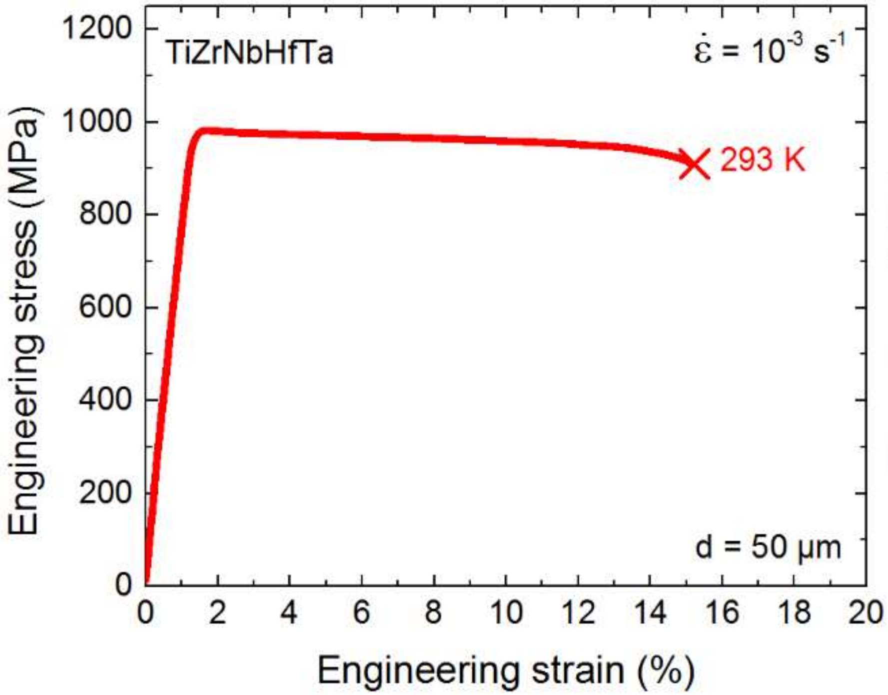


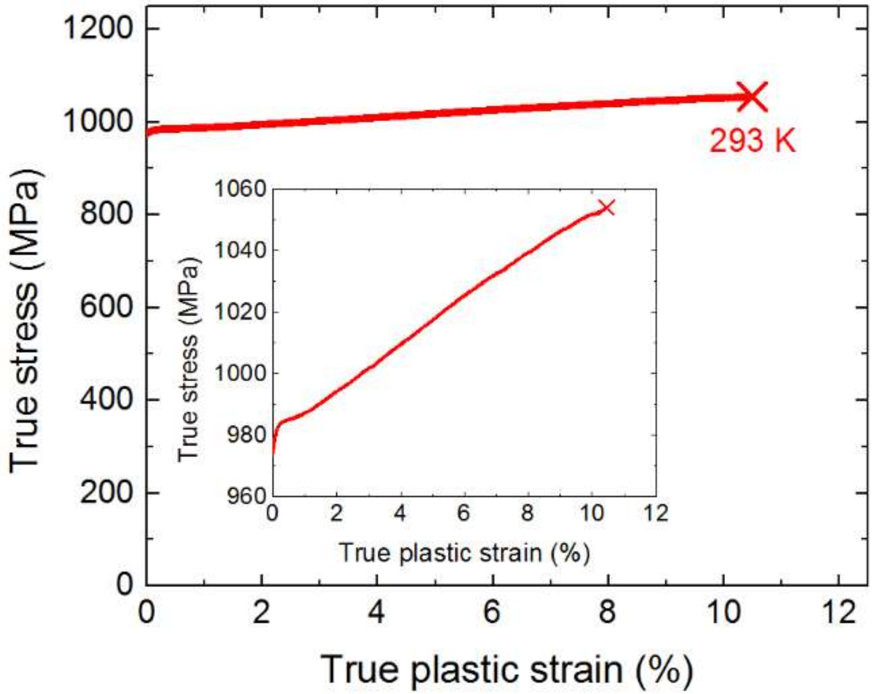


Preliminary work – investigation of a bulk TiZrNbHfTa HEA









Planned cooperation in the frame of the priority programme

- **Effect of a gradient of chemical composition on diffusion kinetics of Zr using radiotracer measurements**
  Dr. S. Divinski, University of Münster

- **STEM comparative study of the structures of HEAs prepared by the laser metal deposition and Bridgeman and Czochralski methods**
  Dr. Markus Heidelmann, University Duisburg-Essen, Germany

- **Assessment of elastic parameters of single crystals**
  Dr. Michael Feuerbacher, Forschungszentrum Jülich GmbH, Germany