Macroscopic Indentation Testing

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Motivation

- Determination of local stress-strain properties using instrumented indentation testing.
- Parameter identification for numerical modelling and simulation.

Method

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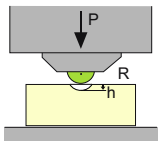
Indendation Test

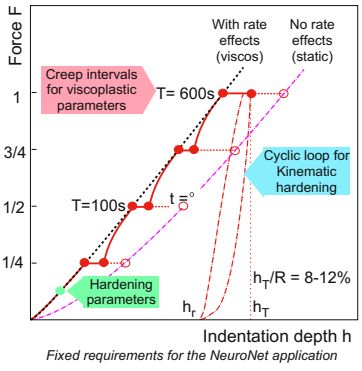
Zwick/Roell Test Machine ZH0.2

Macroscopic indentation



Sphere ball: R = 200 µm

Max force F: 200 N



Fixed requirements for the NeuroNet application

Model & FEA

Viscoplasticity with rate-independent nonlinear isotropic and kinematic hardening and rate-dependent overstress

Armstrong-Frederick hardening rule

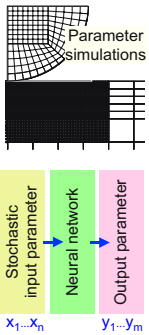
Large deformation theory

E. Diegele, W. Jansohn, C. Tsakmakis: Finite deformation plasticity and visco-plasticity law exhibiting nonlinear hardening rules. Part I: Constitutive theory and numerical integration. Comp. Mech. (2000) 25, 1-12

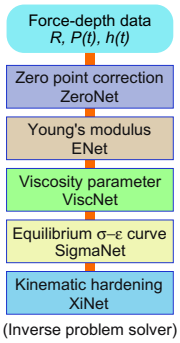
ABAQUS UMAT

Neural Network

Training with FEA

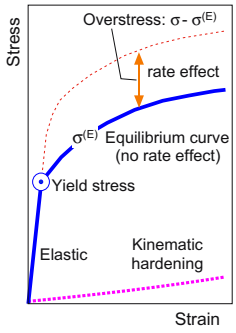


Application Modules



(Inverse problem solver)

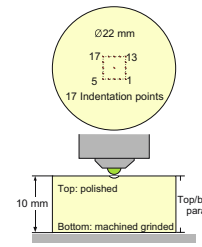
Stress-Strain Curve



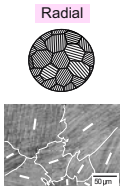
Results

Case A — γ-based Titanium-Aluminide Polycrystal with fully-lamellar grains

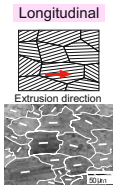
Extruded bar

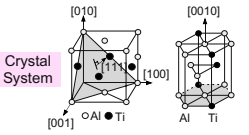


Radial



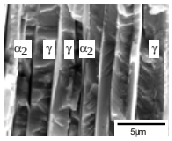
Longitudinal



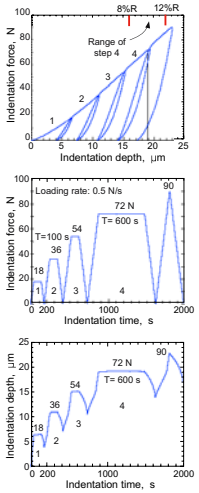


Crystal System

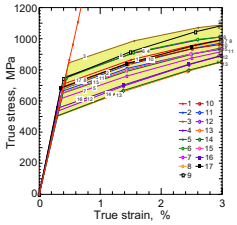
Microstructure



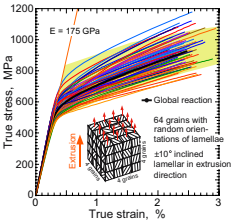
Experimental Curves



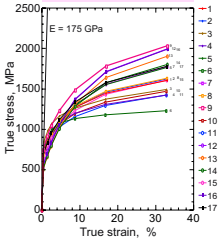
Stress-strain curve Indentation



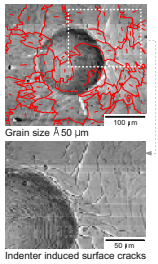
Polycrystal Simulation - 64 grains



Stress-Strain Curves



Real Indentation Point

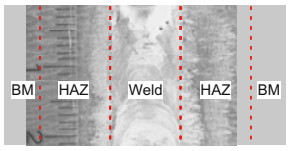


Summary

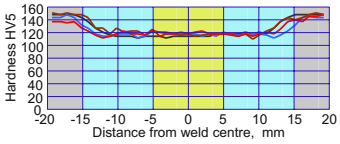
- Good coincidence between indentation and crystal simulation.
- Indentation testing provides large variation of local stress-strain curves.

Case B — Weld joint of rolled 3 mm thick Al 5083-H321 sheet

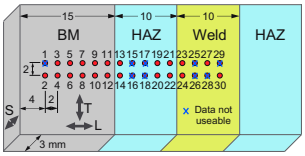
Weld joint



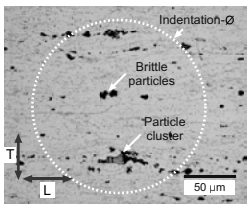
Vickers hardness accross the weld joint



Indentations accross the weld joint

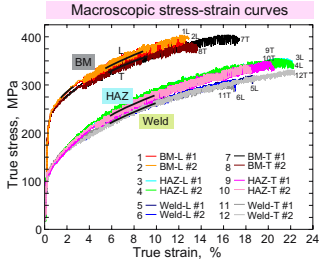


Microstructure

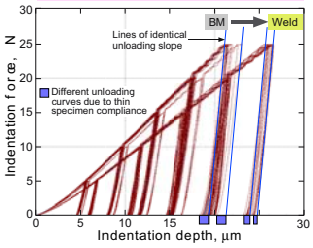


Al 5083-H321, rolled sheet, 3 mm thick

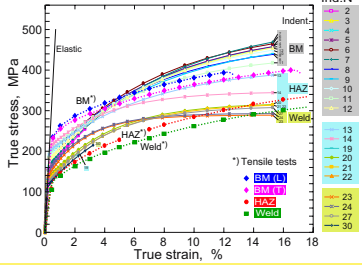
Macroscopic stress-strain curves



Indendation curves



Stress-strain curves - comparison



Summary

- Stress-strain curves from indentation test of weld- and base-material are similar to conventional tensile tests.
- Improvement of the method is required: - Preparation of welded thin sheet specimens.
  - Influence of residual stresses.