How microstructure properties influence the passive behavior of stainless steel

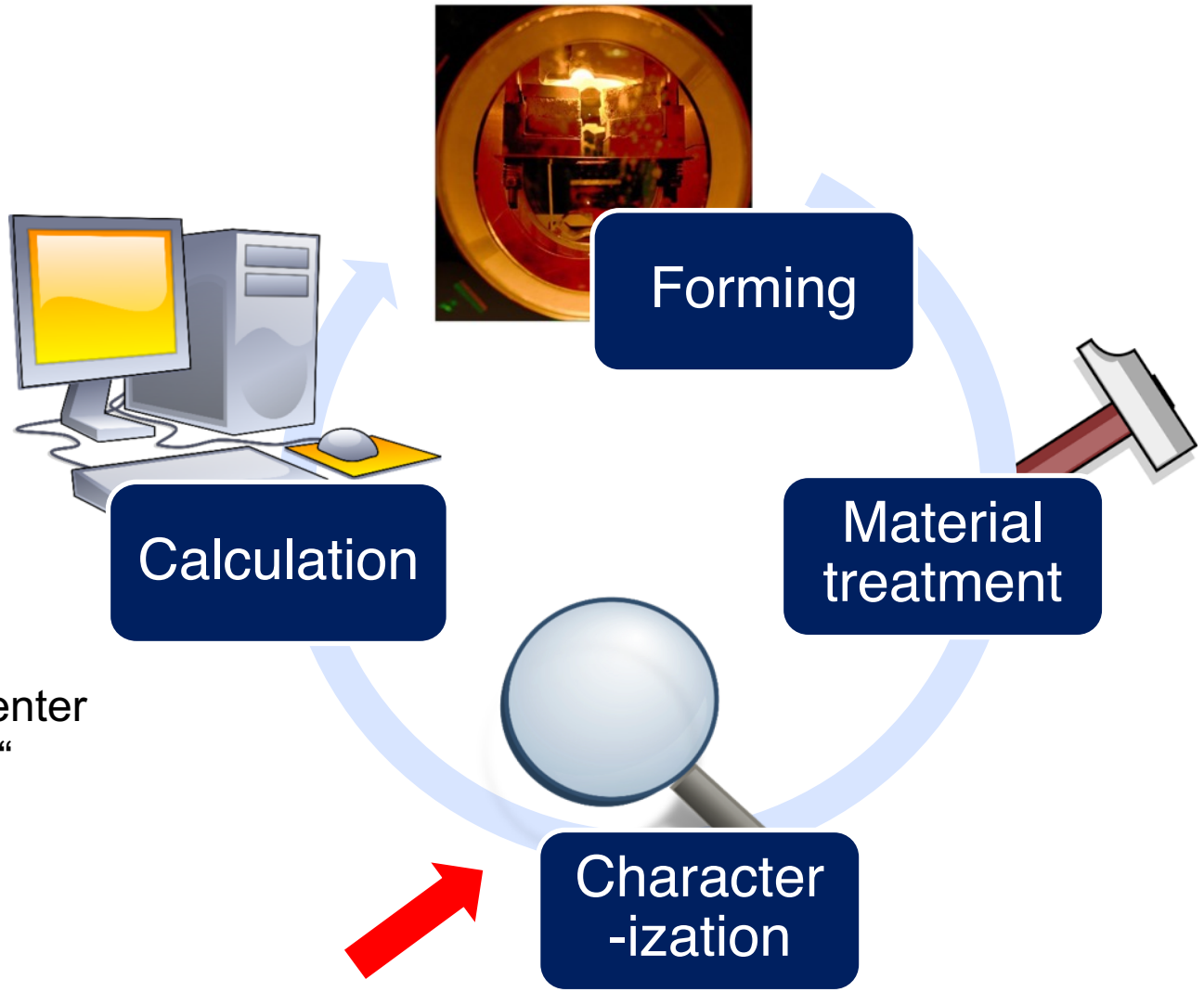
Ingmar Bösing
Michael Baune
Jorg Thöming

CHEMISCHE VERFAHRENS-TECHNIK

Chemical Process Engineering
Group

Bremen, Germany


Universität Bremen



Collaborative Research Center
SFB 1232 „Colored States“

sfb1232.de

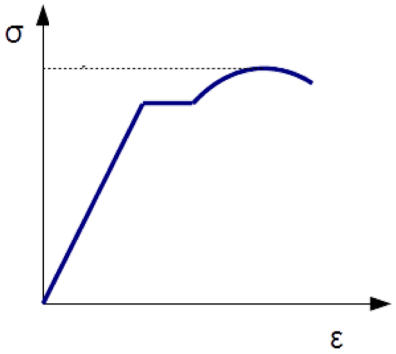
Ingmar Bösing
Ingmar.boesing@uni-bremen.de

Austenitizing

Mechanical deformation

Two different treatments

Change in microstructure



Mechanical Properties

Oxide Layer

Metal

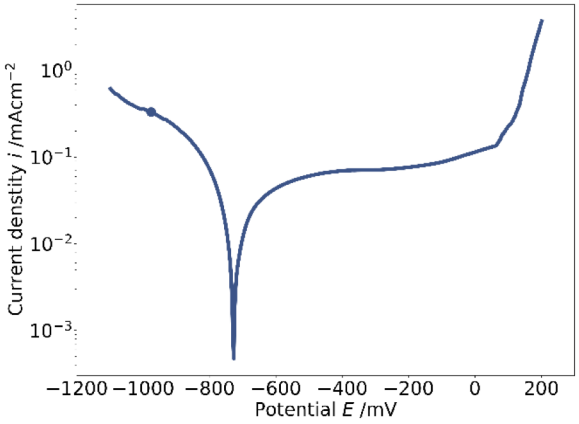
Passivity

How do this treatments influence the passivity?

Ingmar Bösing
Ingmar.boesing@uni-bremen.de

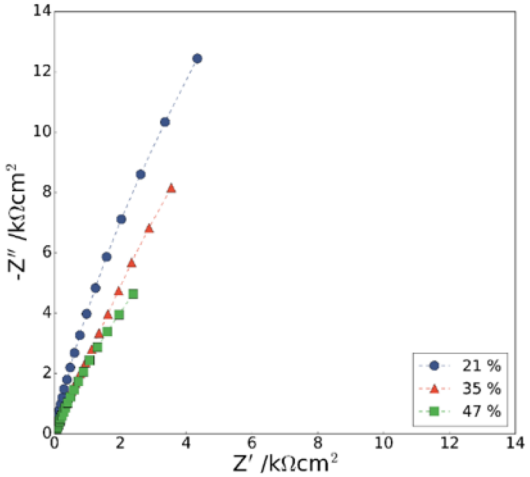
Methods

Linear Sweep Voltammetry



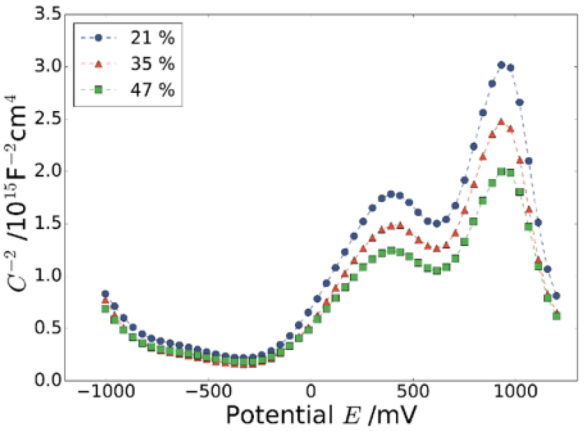
Corrosion current
Corrosion potential
Pitting potential

Impedance Spectroscopy



Equivalent electrical circuit parameters

Mott-Schottky Analysis

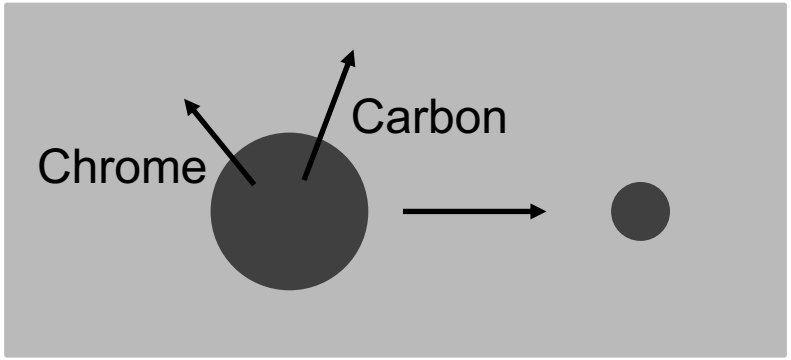


Defect density inside the passive layer

Ingmar Bösing
Ingmar.boesing@uni-bremen.de

Heat Treatment

Austenitizing



Dissolution of chrome carbides

- Release of chrome and carbon
- Higher temperature -> higher dissolution

Increasing grain size

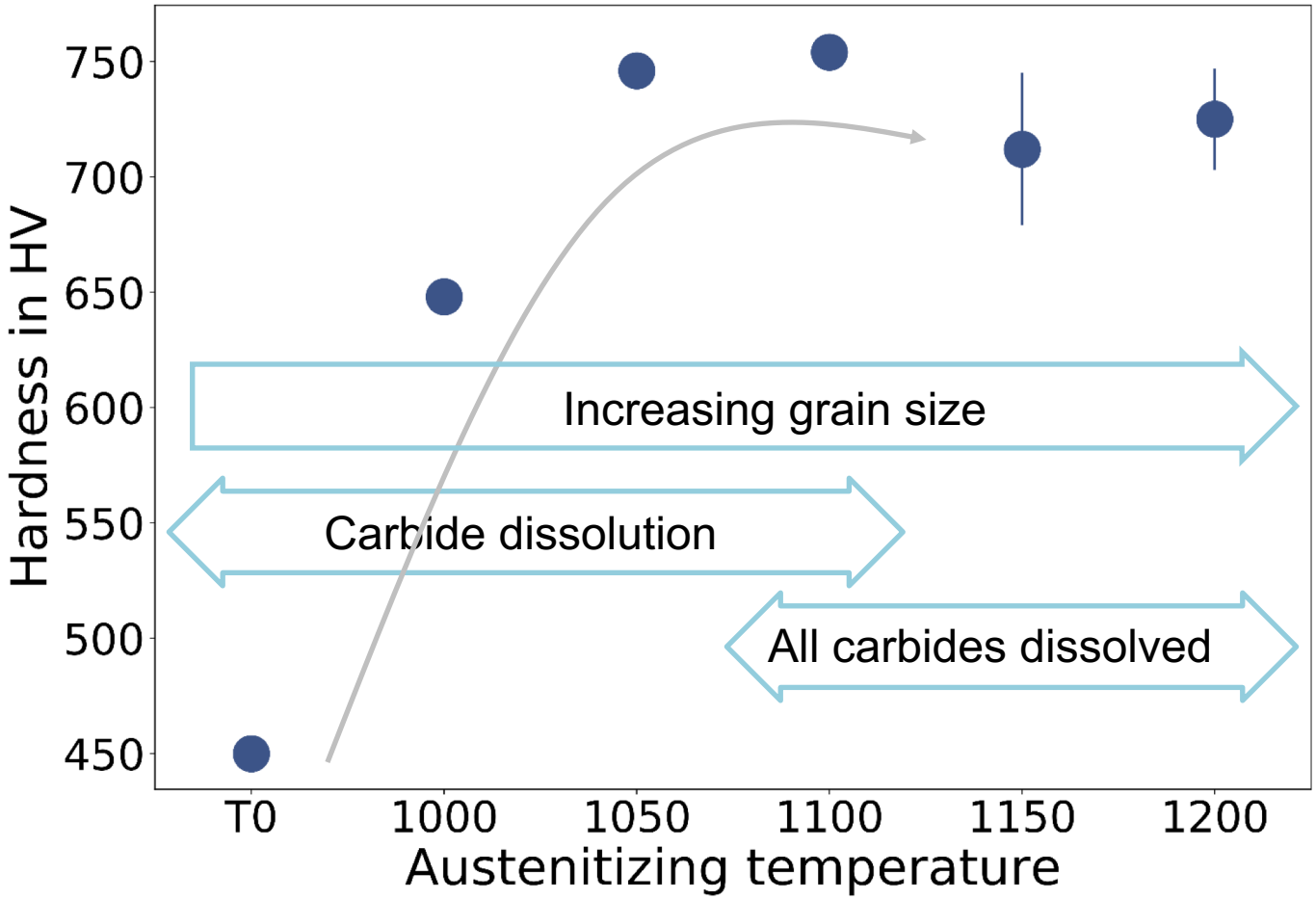
- Higher temperature -> larger grains

Martensite formation

Increasing hardness

Ingmar Bösing
Ingmar.boesing@uni-bremen.de

Hardness



Ingmar Bösing
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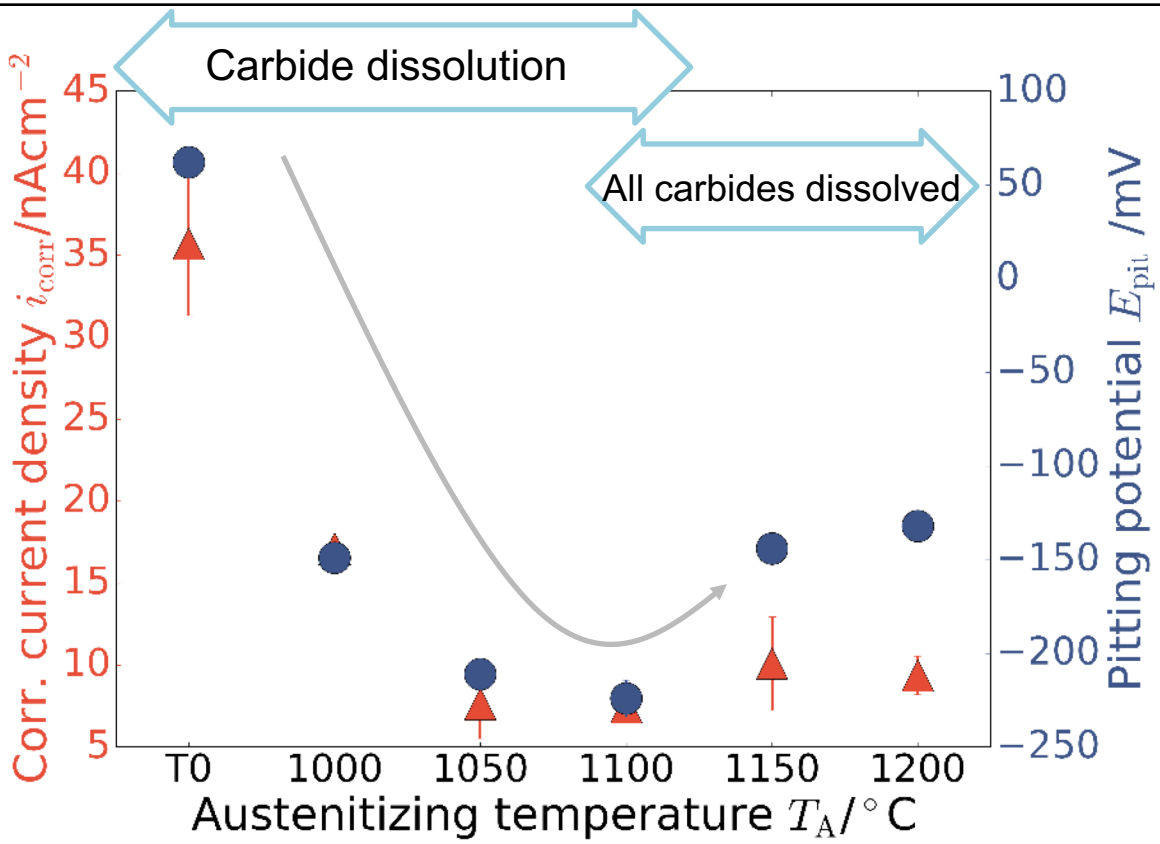
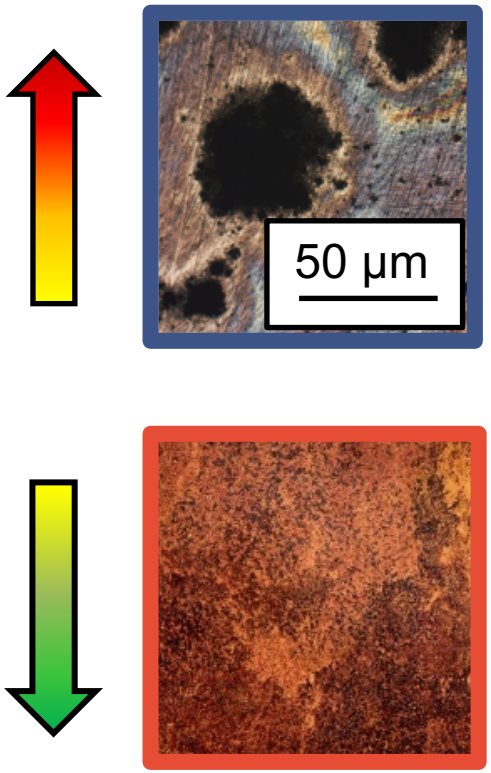


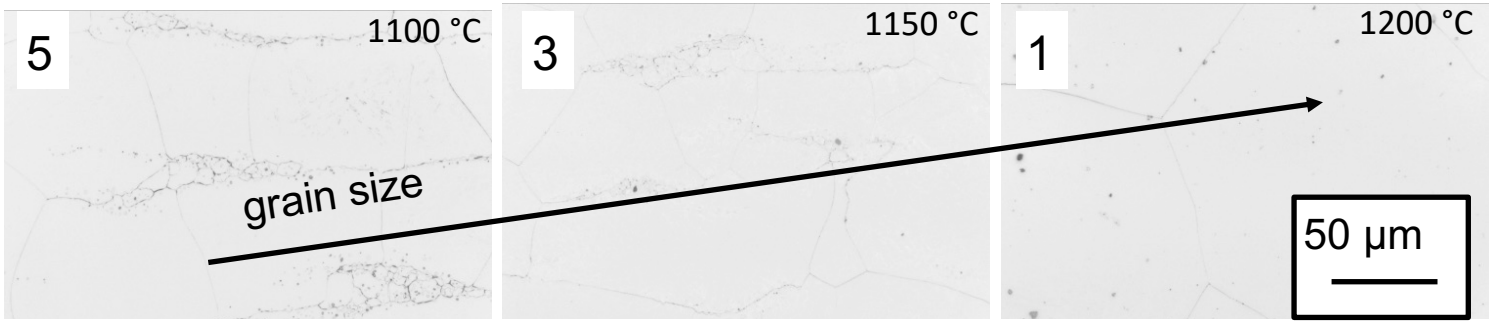


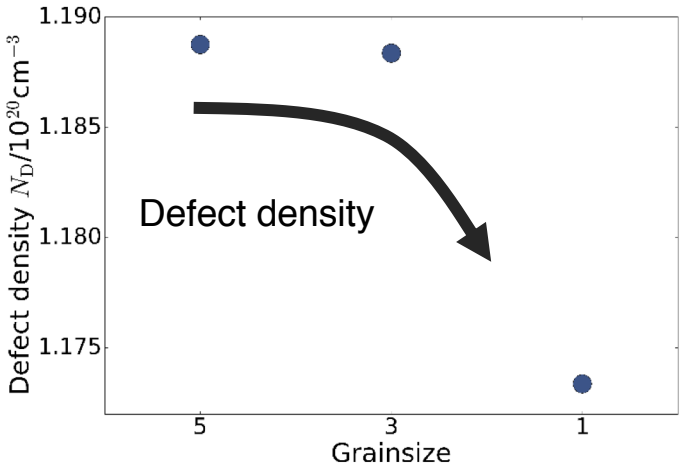
Increasing pitting corrosion ●

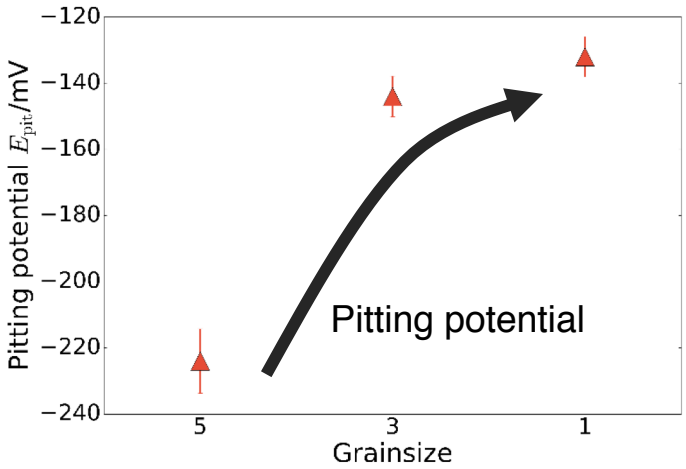
Decreasing general corrosion ▲

Ingmar Bösing
Ingmar.boesing@uni-bremen.de

Influence of grain size

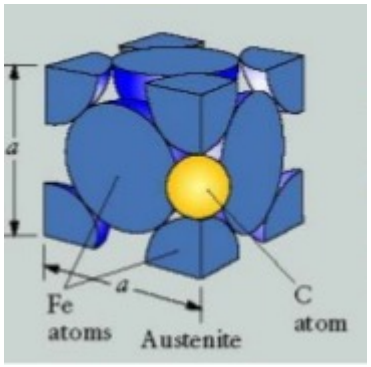


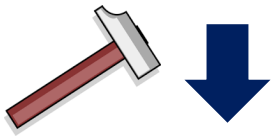


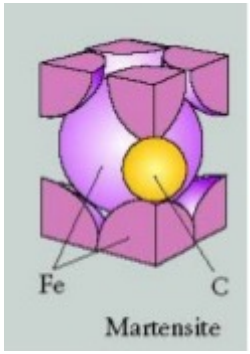


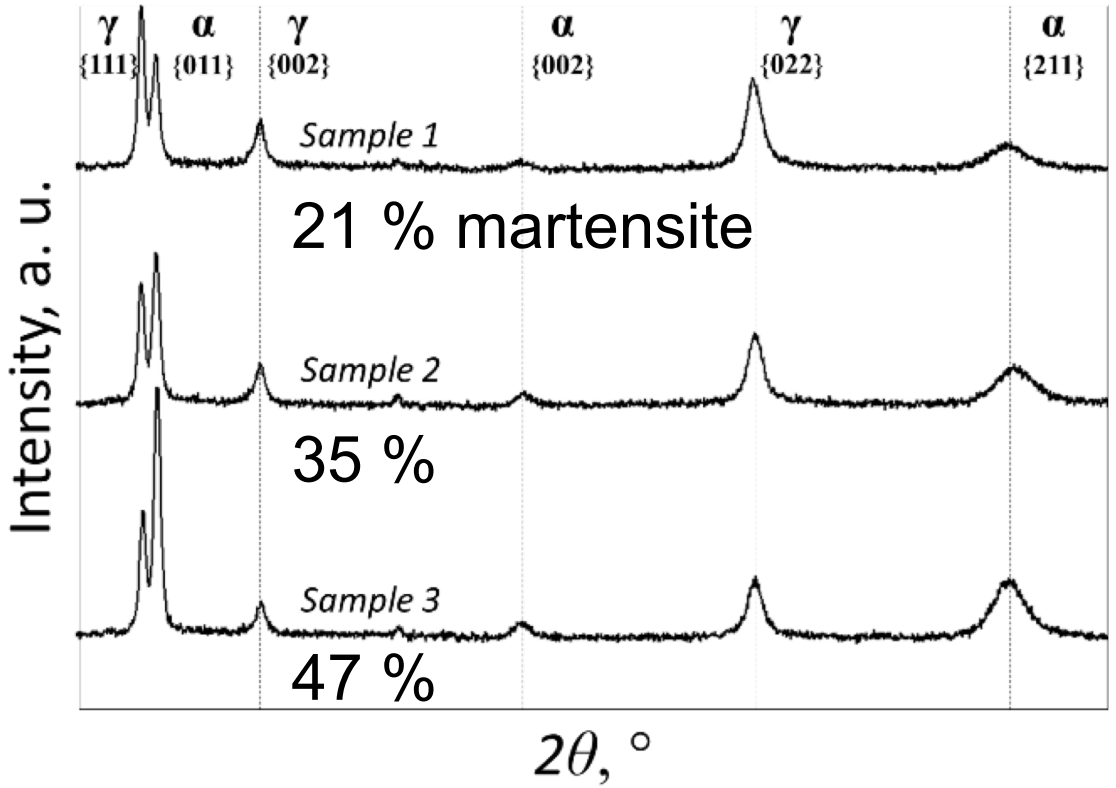
Ingmar Bösing
Ingmar.boesing@uni-bremen.de

Mechanical deformation









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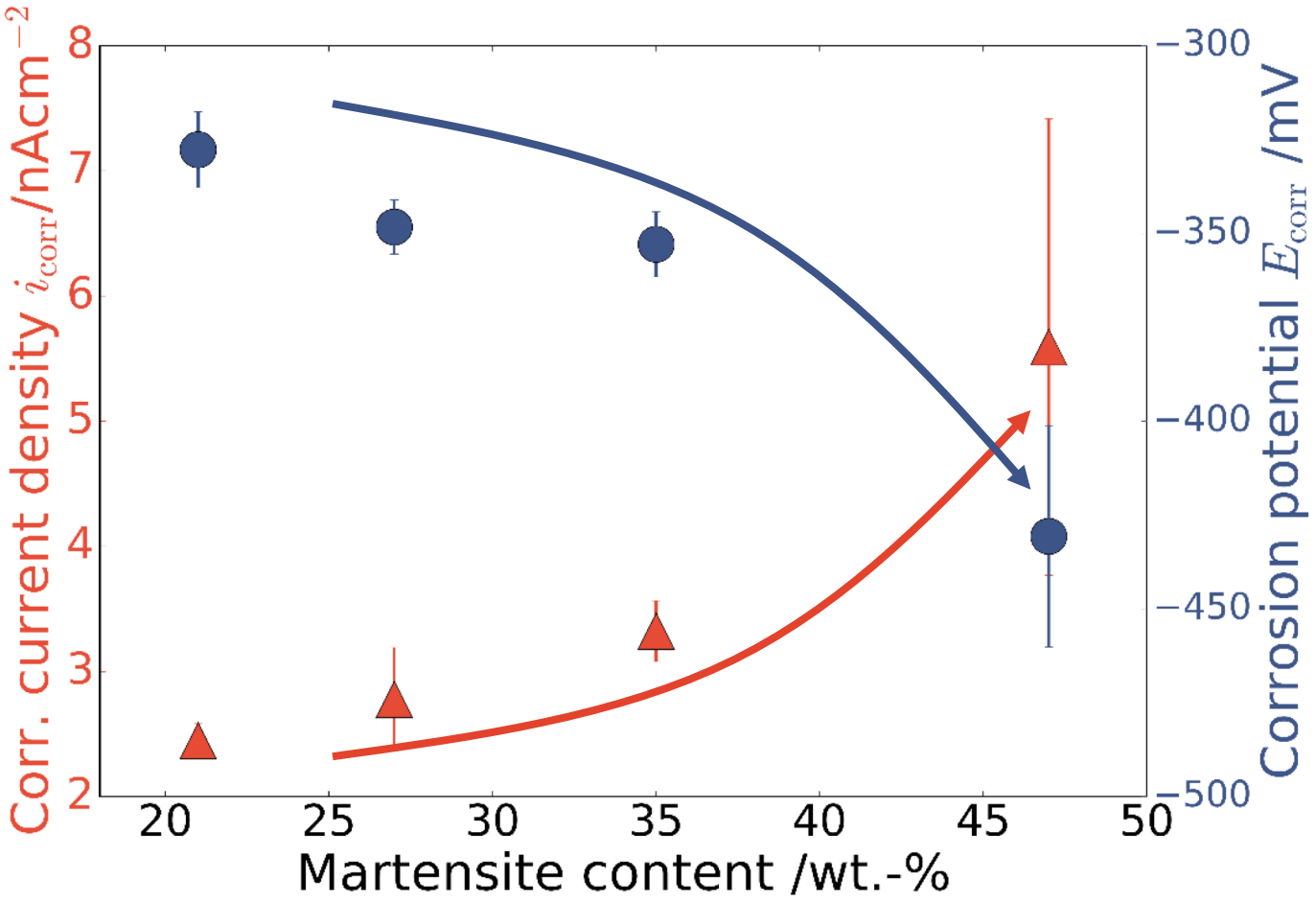
Ingmar Bösing
Ingmar.boesing@uni-bremen.de



Ingmar Bösing
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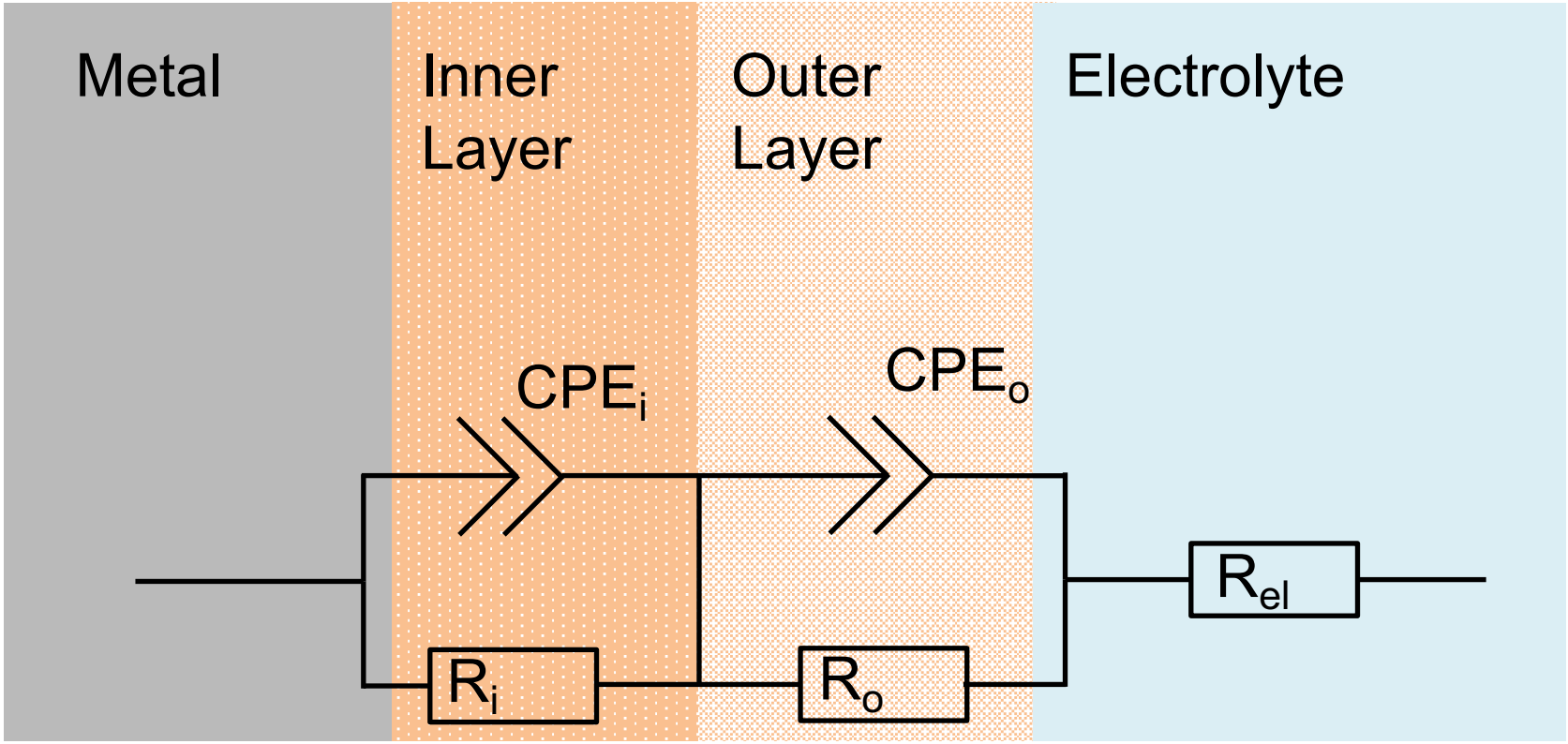

Ingmar Bösing
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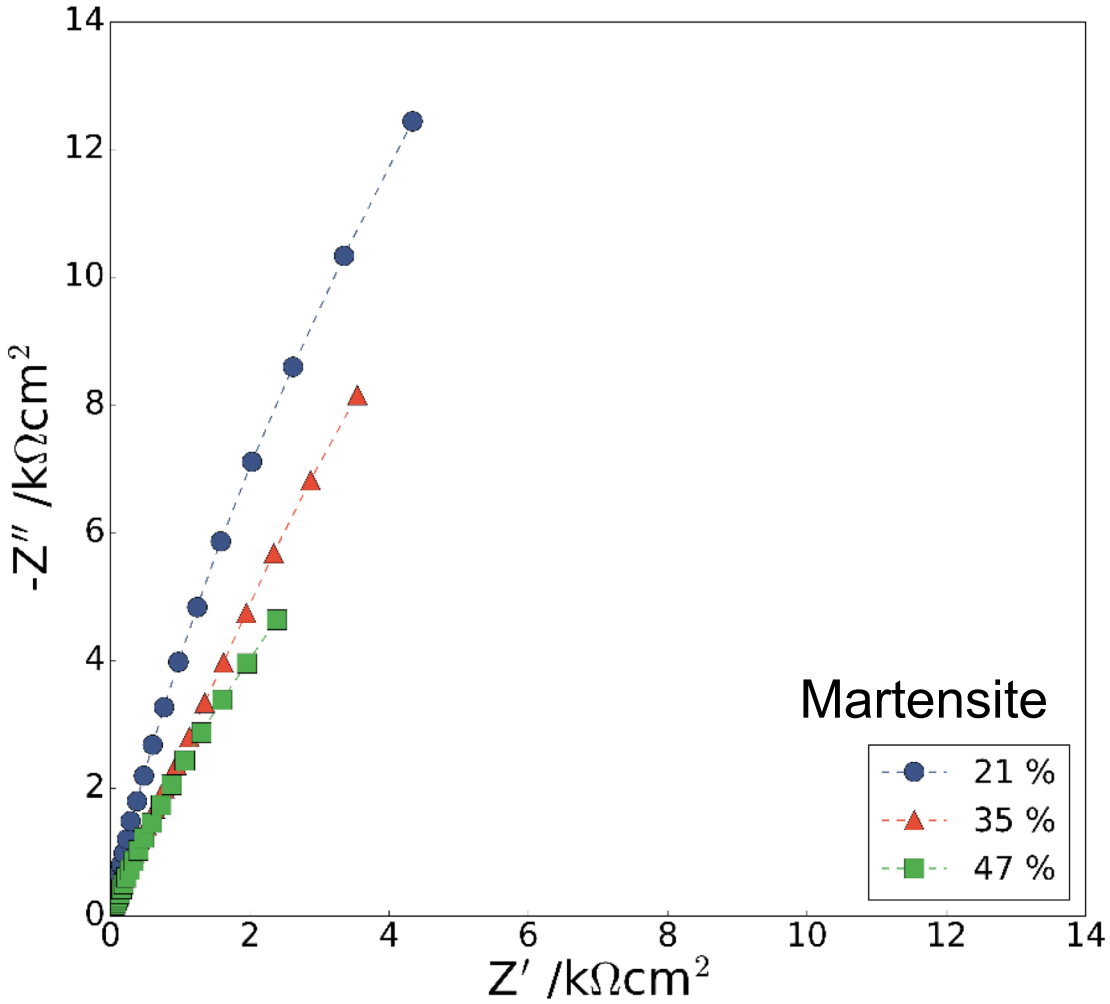
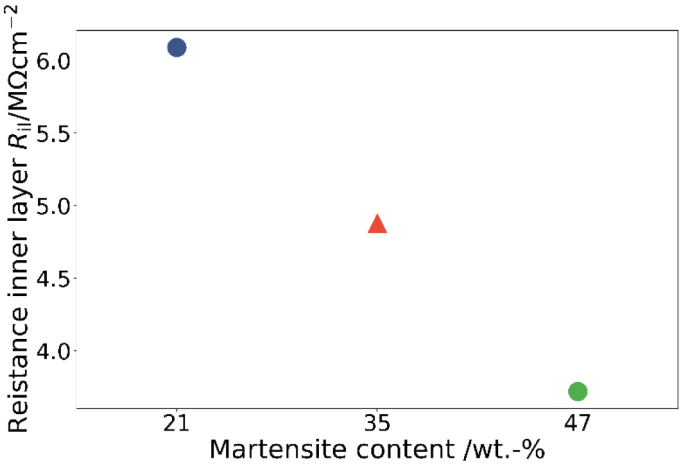


Martensite content	R_o /kΩmm²	R_i /kΩmm²
21%	6	6090
35%	4	4880
47%	2	3720



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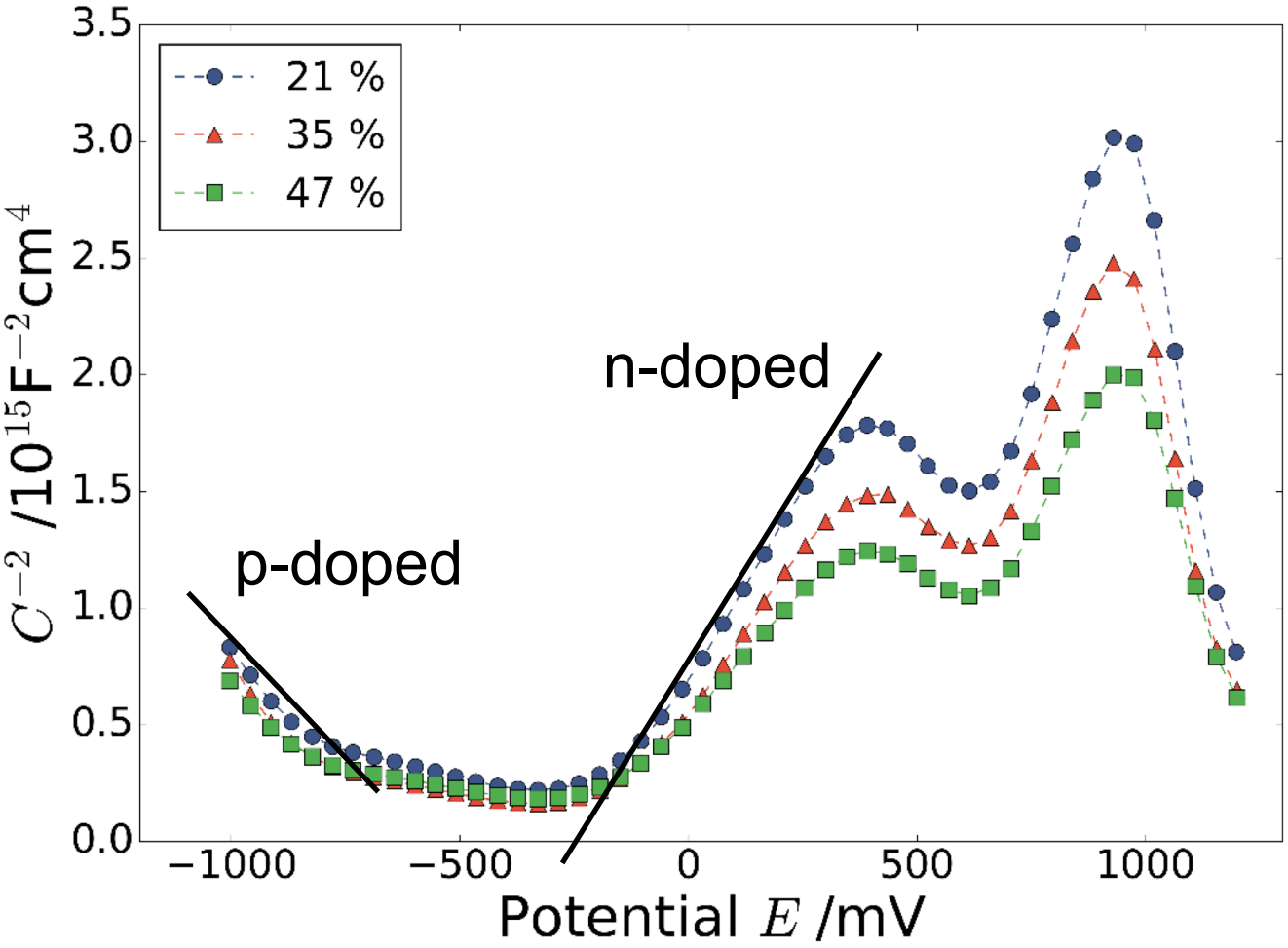

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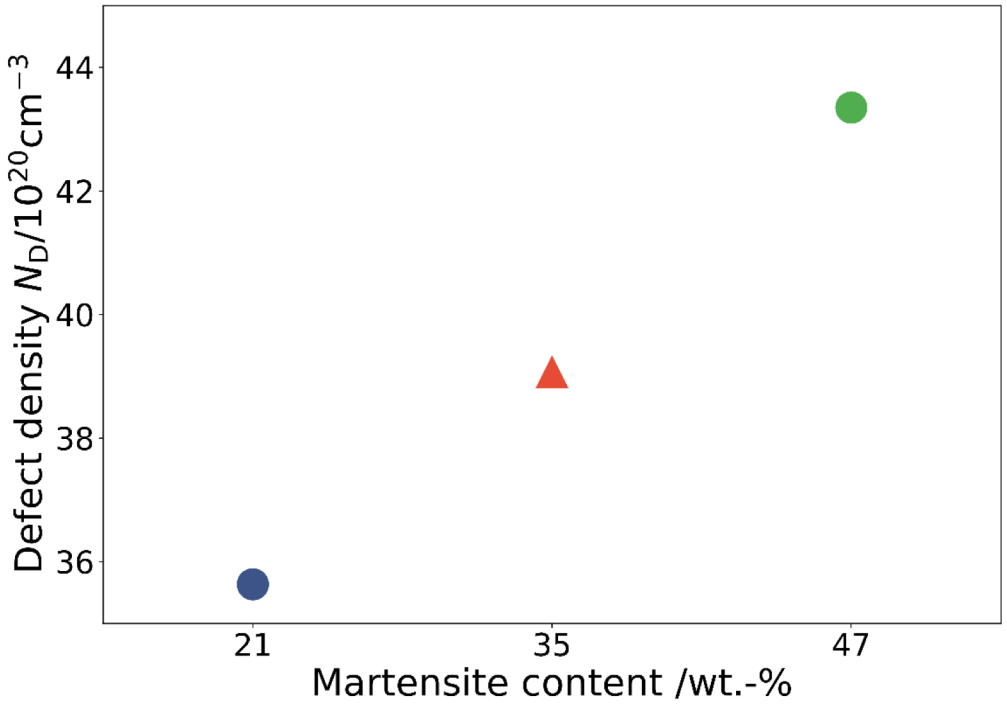

$$\frac{1}{C_{SC}^2} = \frac{2}{\varepsilon\varepsilon_0 e N_D}\left(E - E_{fb} - \frac{kT}{e}\right)$$

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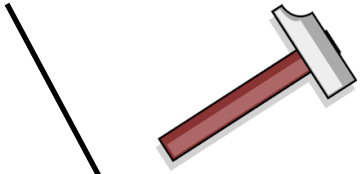
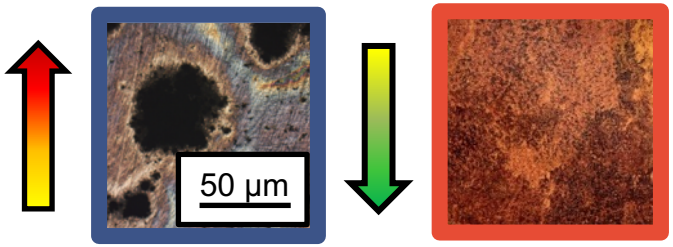
Microstructure changes

Austenitizing



Mechanical deformation



Two contradictory areas

Increasing martensite content → Increasing corrosion susceptibility

Ingmar Bösing
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Thank you for your attention

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https://www.uni-bremen.de/en/vdw/

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