



Ultrafeinkörnige Stähle

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Presented as lecture on the Max-Planck Hot Forming Conference Dec. 5th 2002 at the Max-Planck-Institut für Eisenforschung



- **Warmumformsimulation mit „WUMSI“**
- **Ultrafeinkörnige Stähle**

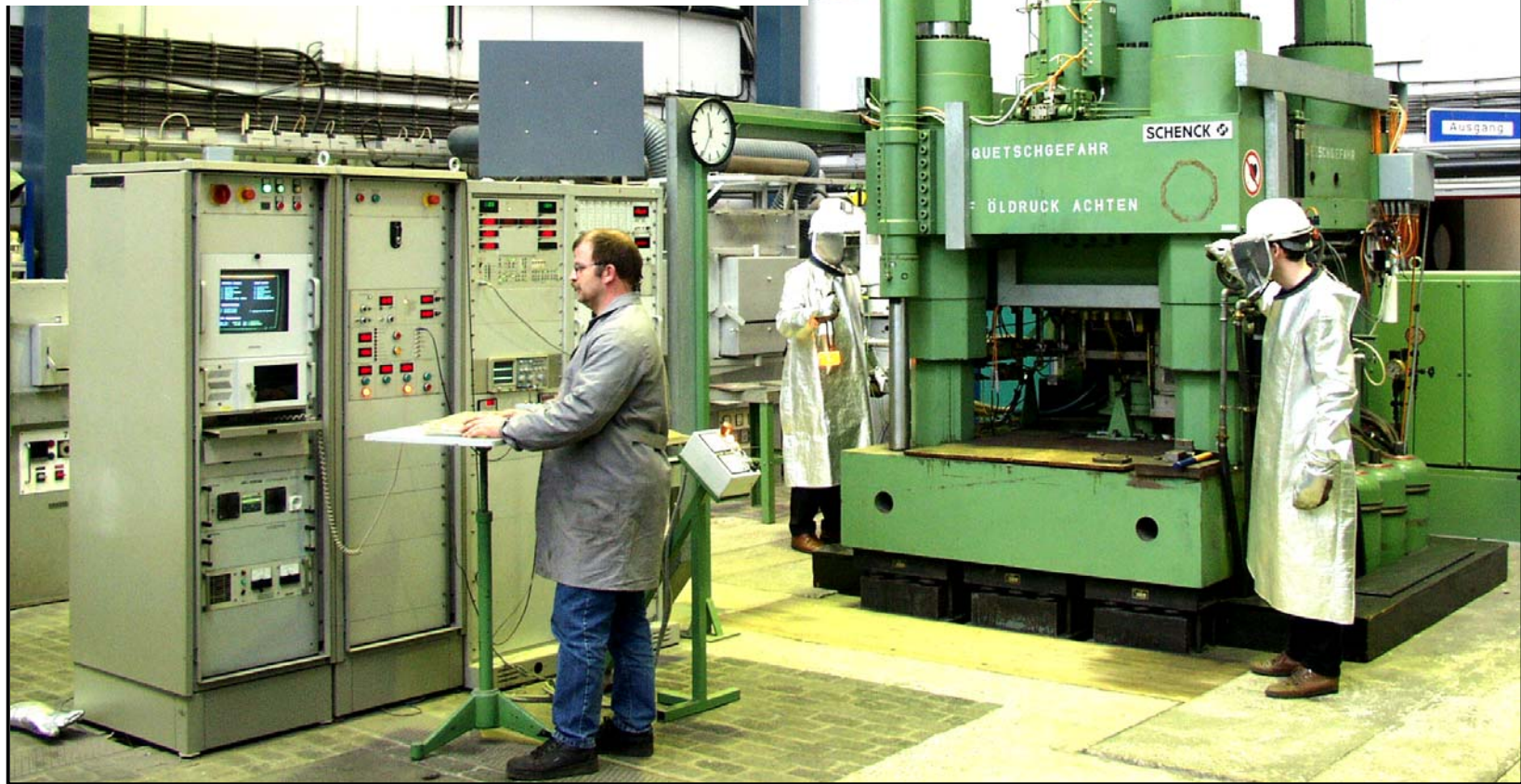


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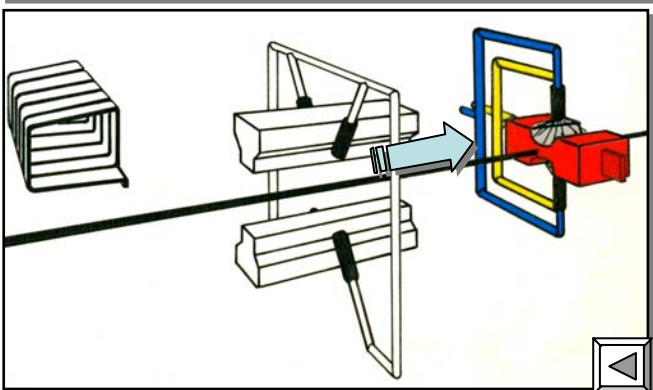
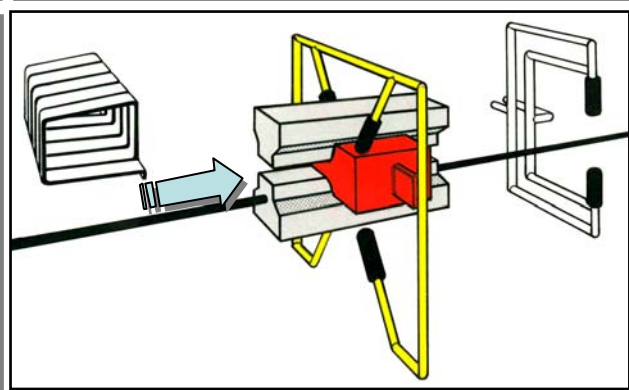
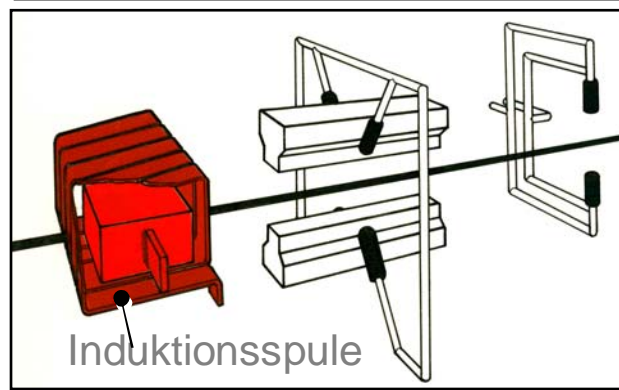
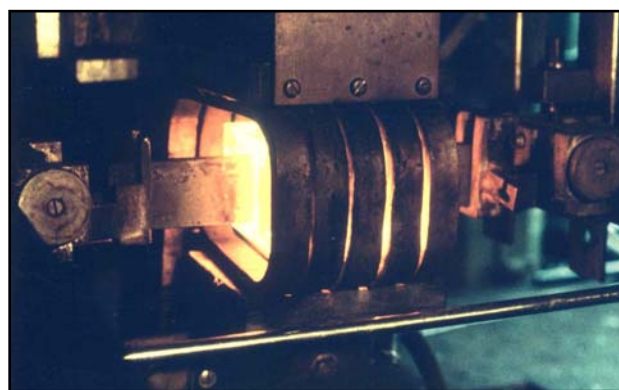
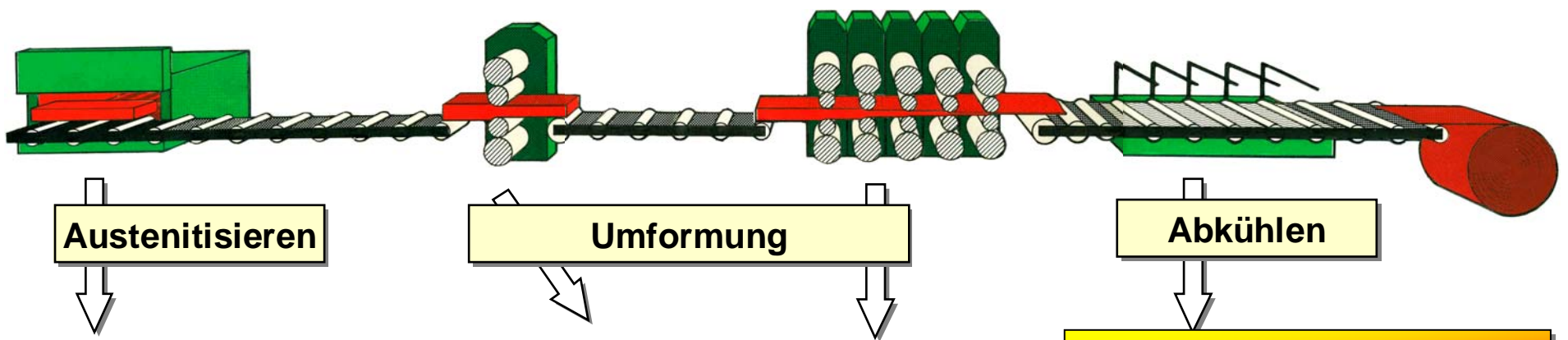
Der WarmUMformSimulator

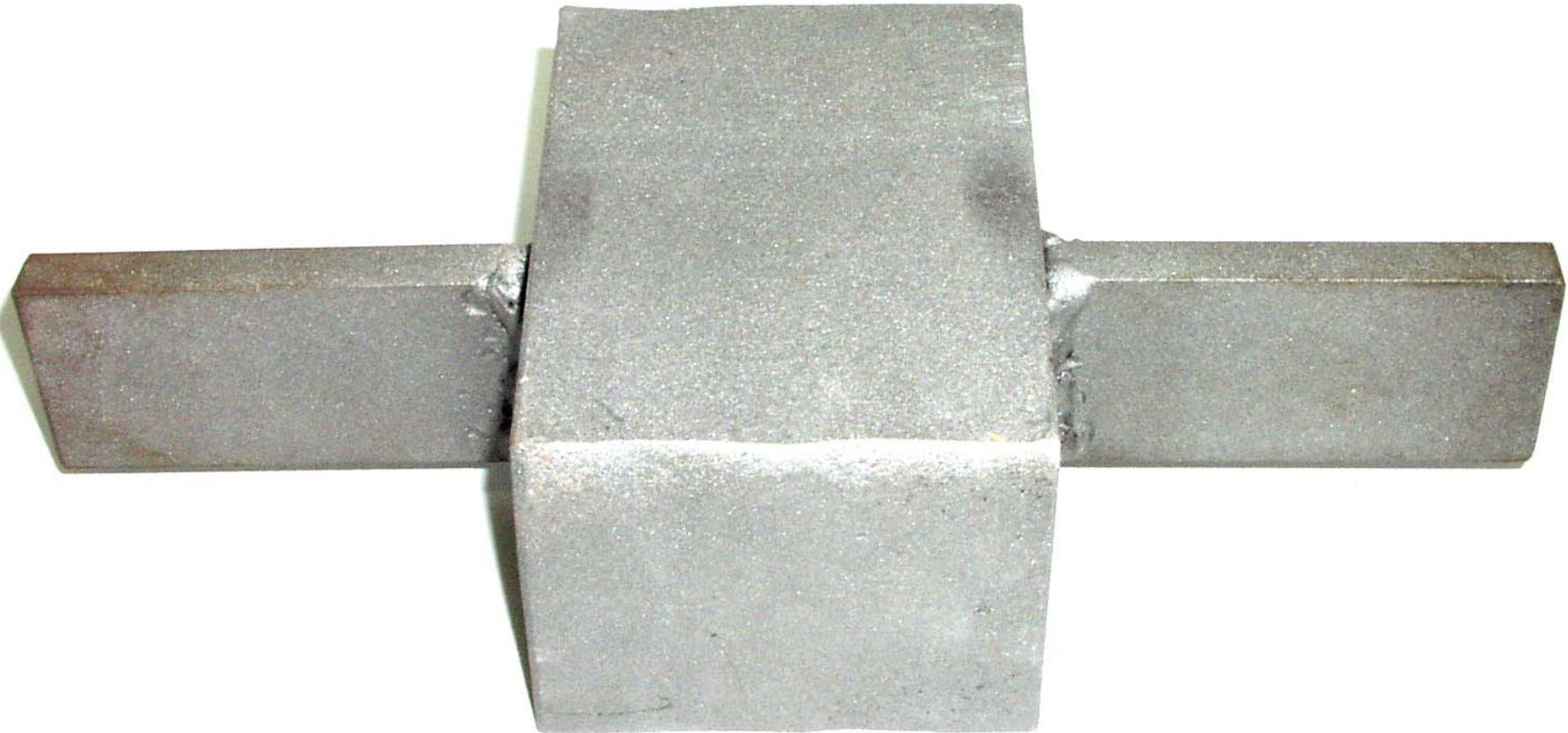


WUMSI



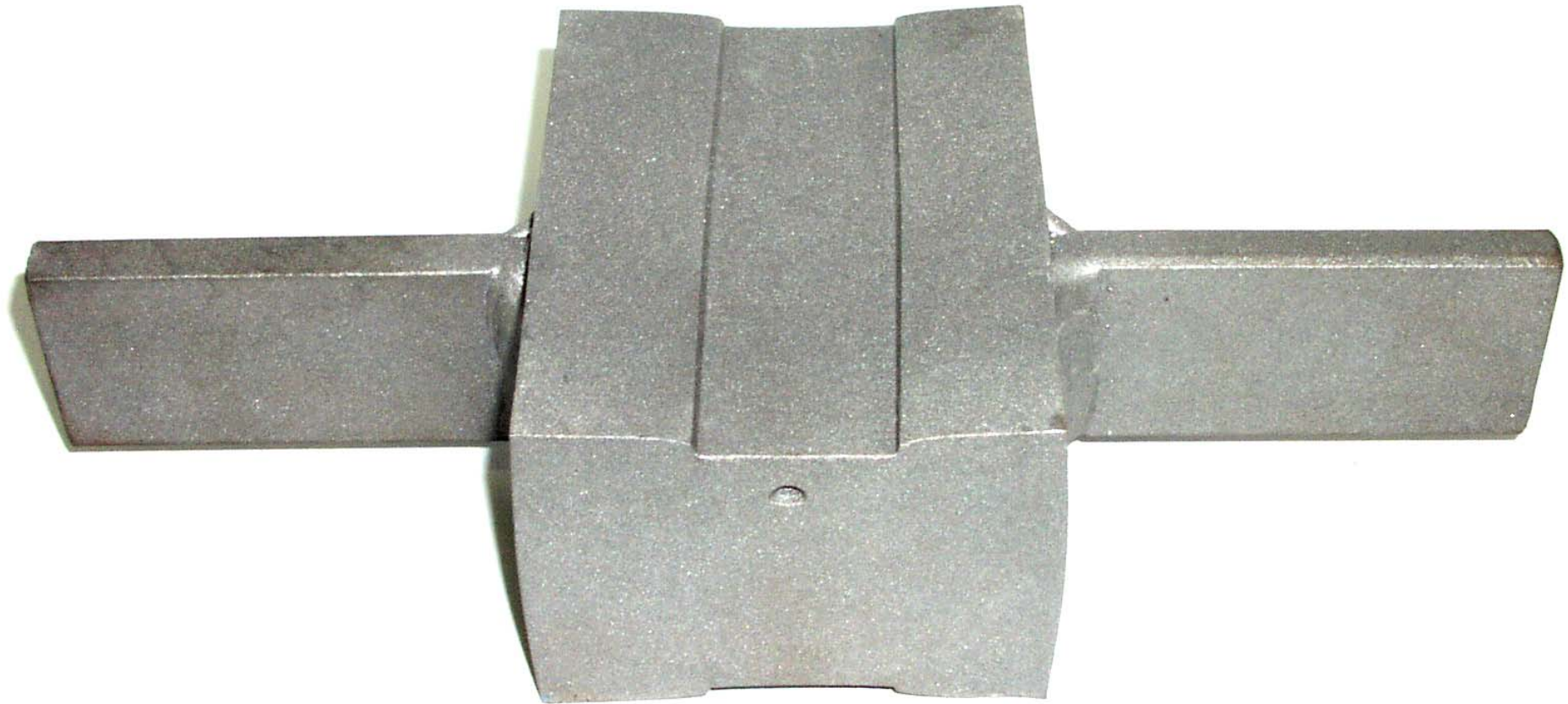
Ablauf einer Warmumformsimulation





Ausgangsmaterial

Flachstauchversuch



1. Schlag



2. Schlag



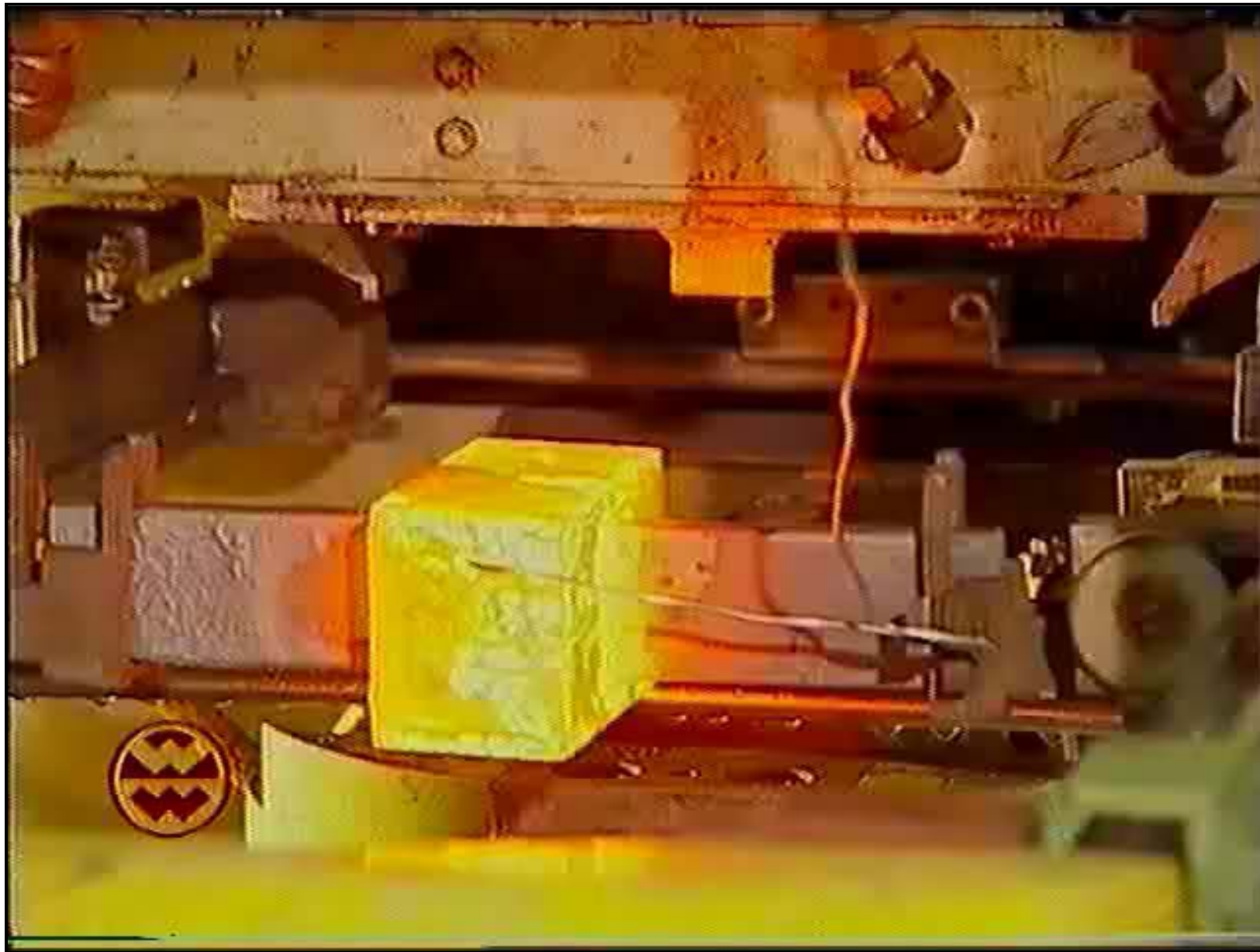
3. Schlag



4. Schlag



Flachstauchversuch



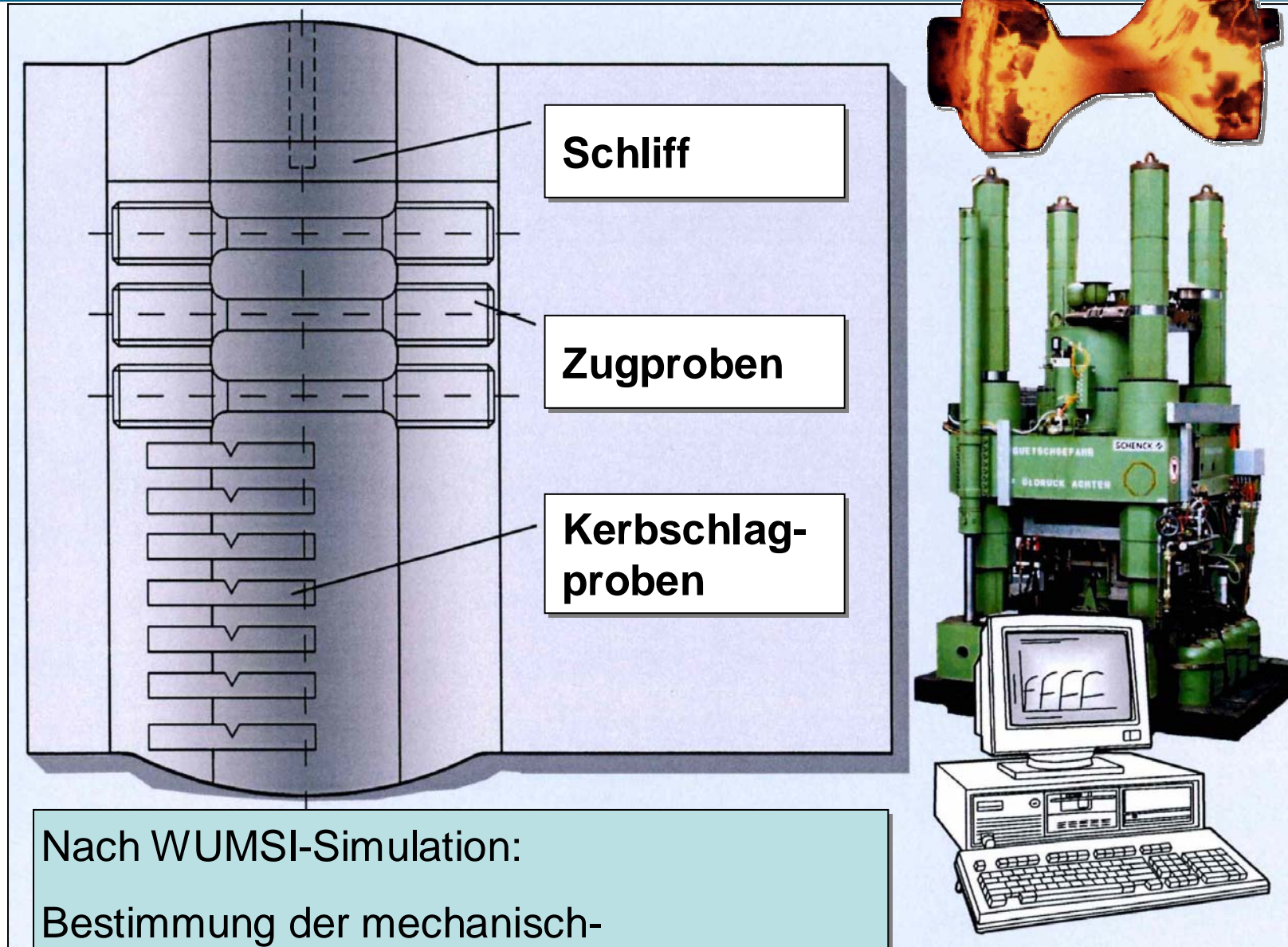
Minimale
Pausen-
zeit: 50ms

$$\varphi_{\max} = 2,5$$

$$\dot{\varphi}_{\max} = 100 \text{ s}^{-1}$$



Sekundärproben



Nach WUMSI-Simulation:
Bestimmung der mechanisch-
technologischen Eigenschaften möglich !

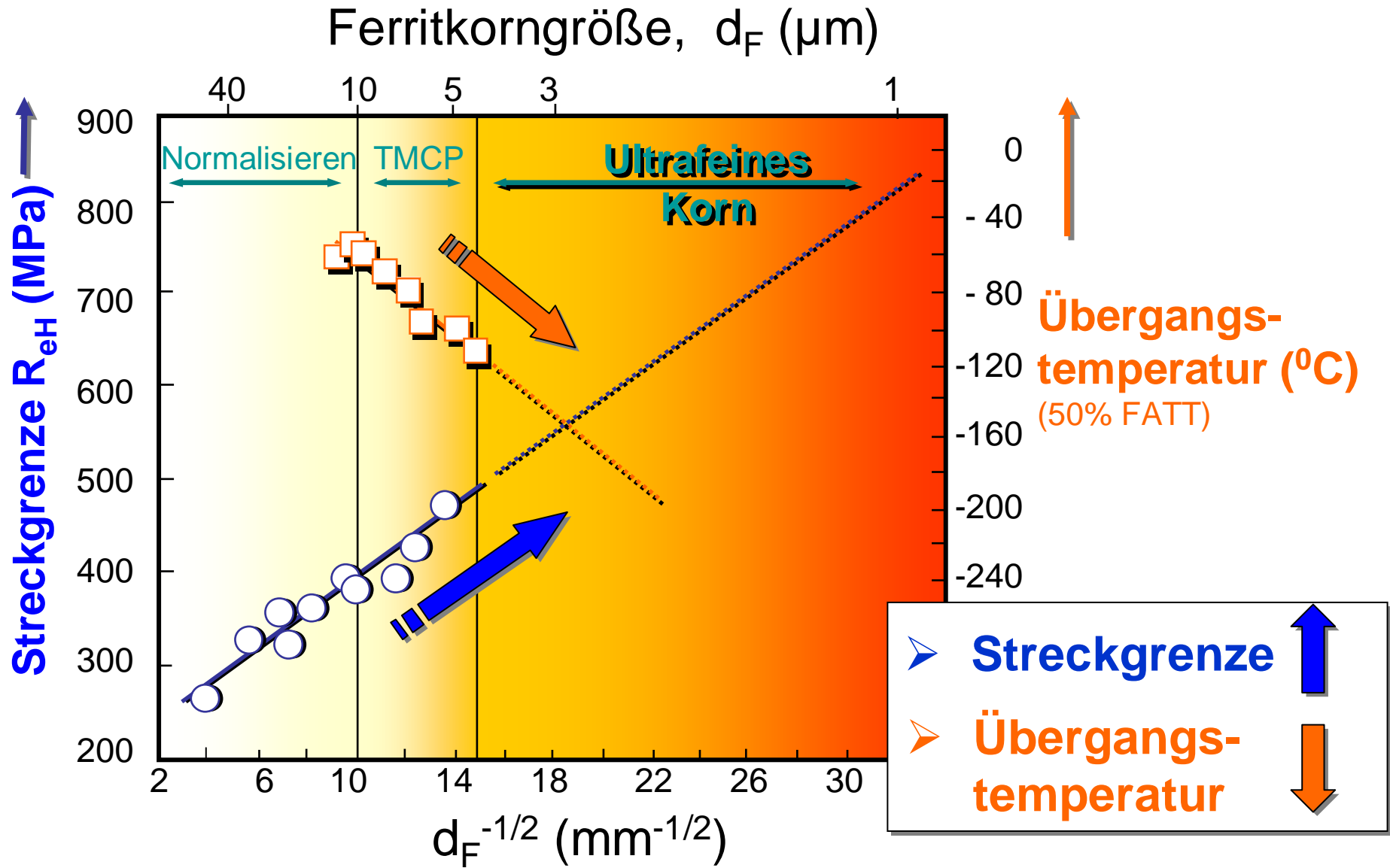


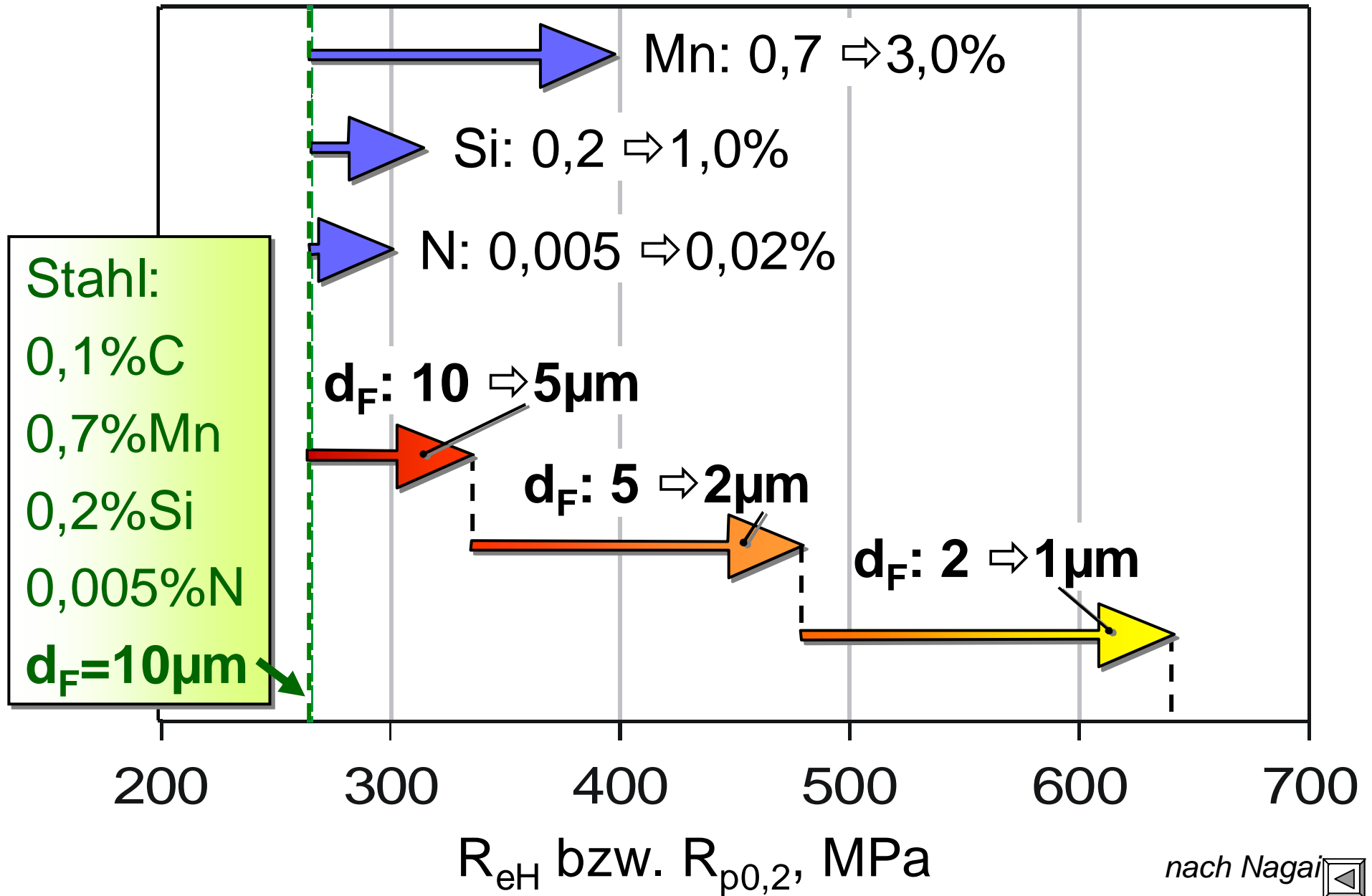
- Warmumformsimulation mit „WUMSI“
- **Ultrafeinkörnige Stähle**



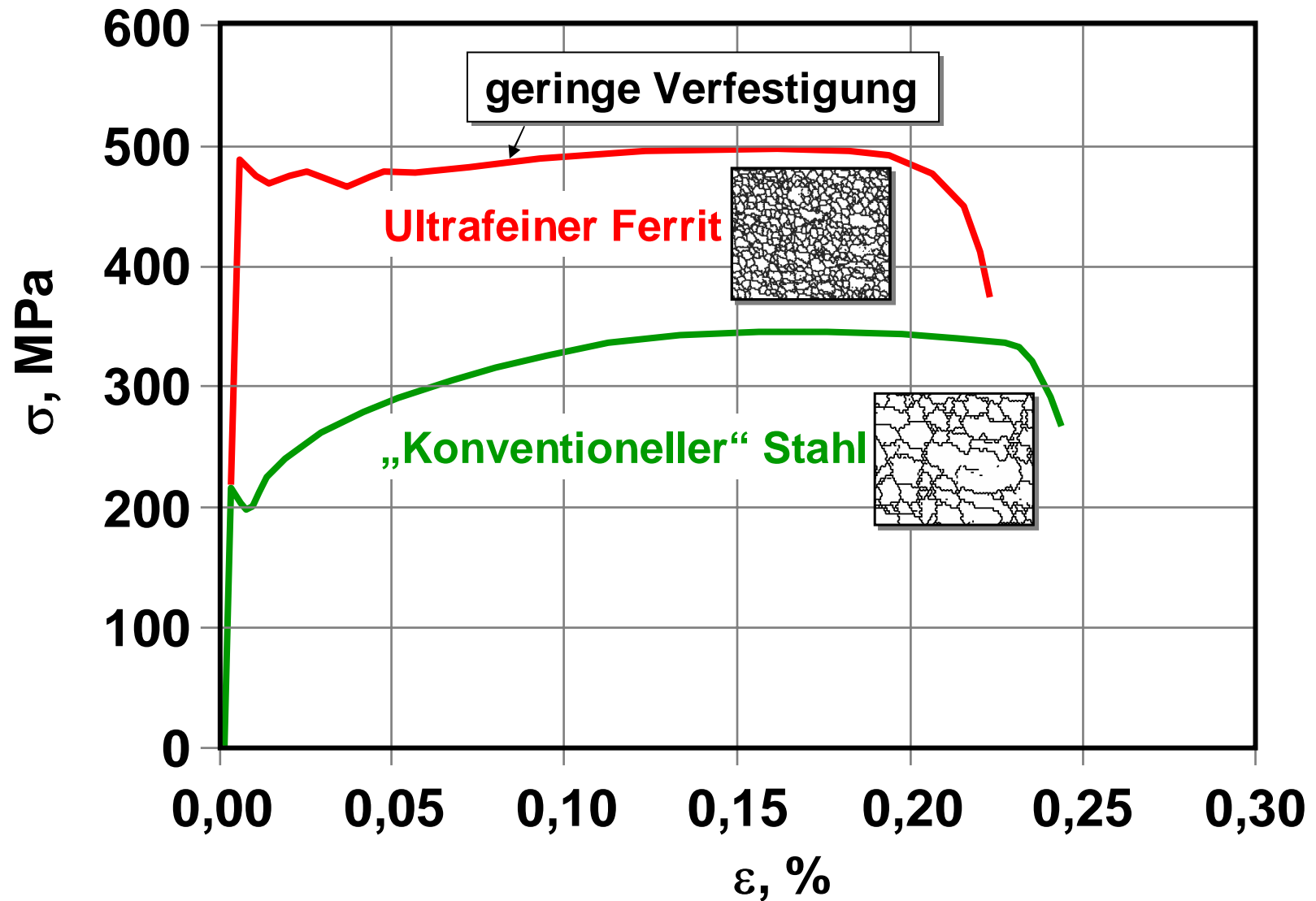
Warum sind ultrafeinkörnige Stähle interessant ?







Probleme/Herausforderungen ...

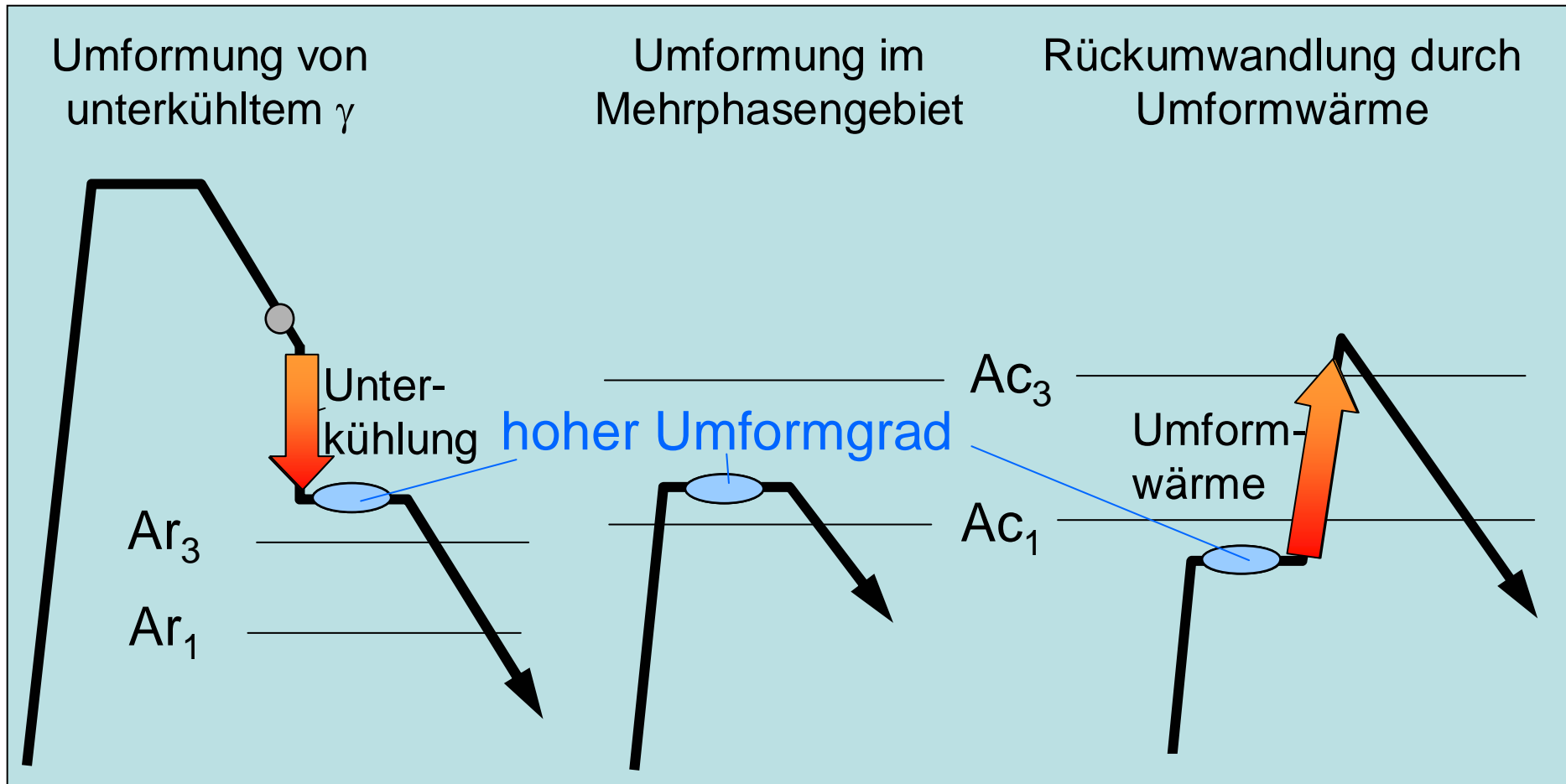




Wie stellt man ultrafeinkörnigen Stahl her ?

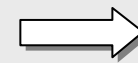


Hohe Anforderungen bei neuen Routen



Niikura et al.

- hoher Umformgrad pro Stich
- schnelles Abkühlen/Aufheizen
- enge Prozessfenster



schwierig für
industrielle
Großproduktion !





- Ultrafeines Korn in nicht legierten C-Mn-Stahl (keine Legierungskosten, gut zu recyclieren)

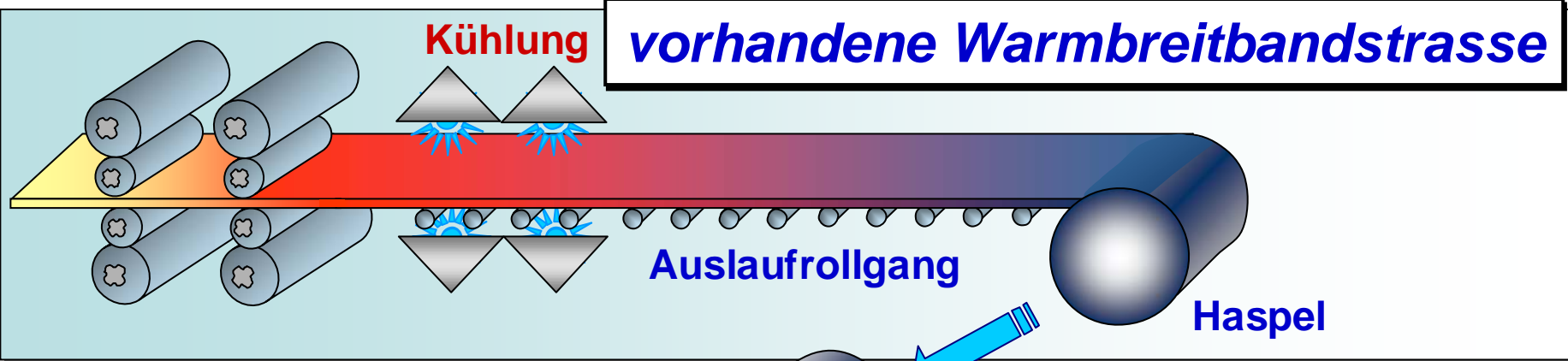
	C	Si	Mn	P	S	Al	N
0,3%C	0,31	0,22	0,76	0,003	0,003	0,03	0,001

- Feine und homogene Verteilung von Zementit (Erhöhung der Verfestigung, Stabilität)
- Zusammenhänge Gefüge-Eigenschaften in ultrafeinen Stählen
- Anwendbar für industrielle Produktion



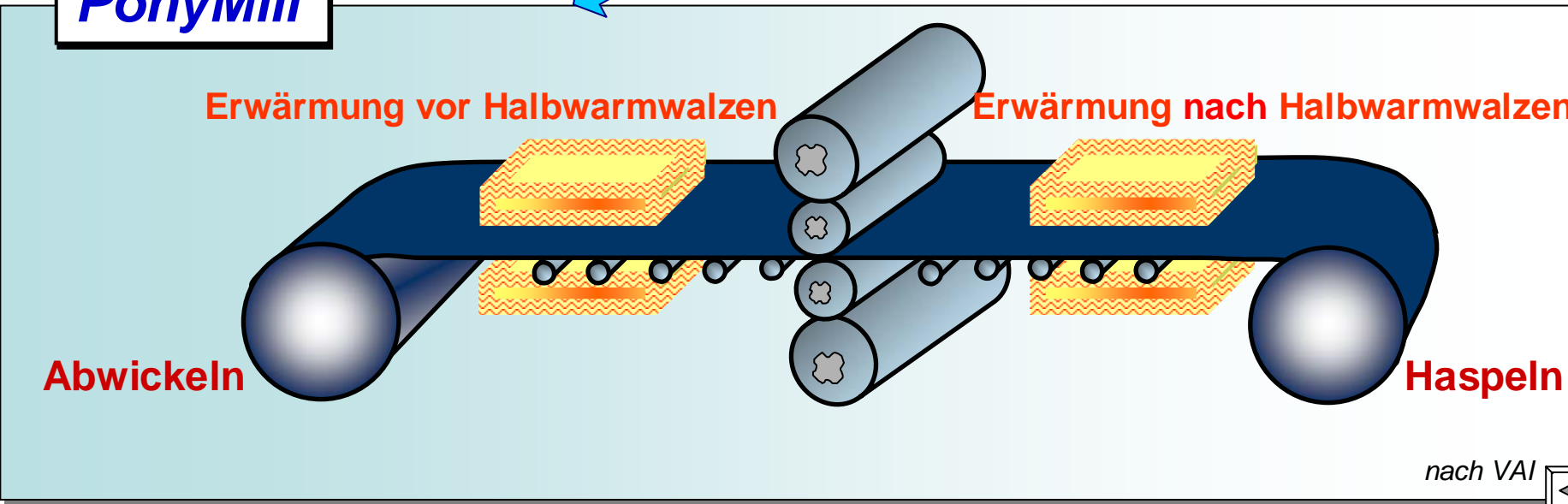


Pony Mill - Konzept



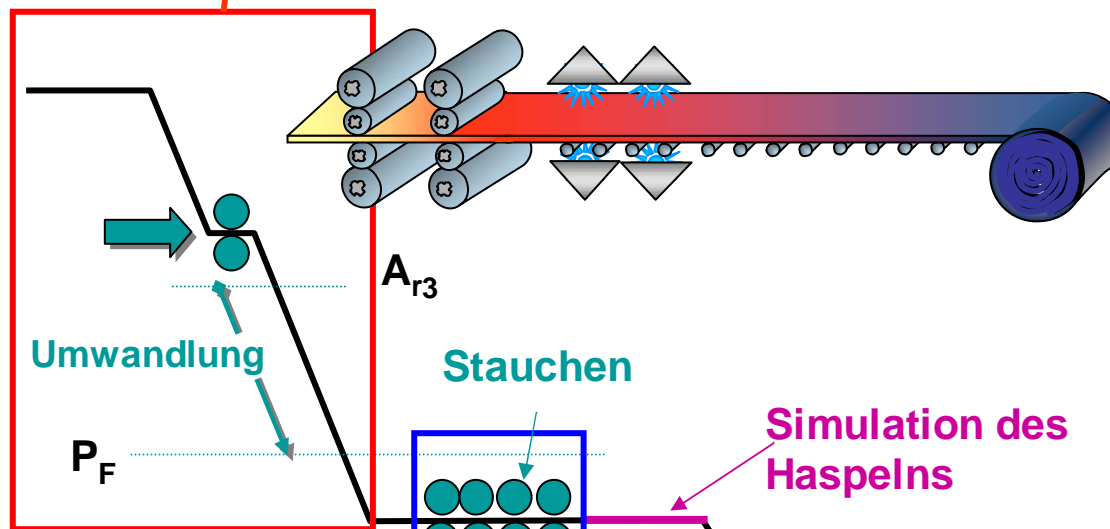
Bund-Transfer

PonyMill



„Perlit-Route“

Warmumformung (Warmbreitbandstraße)



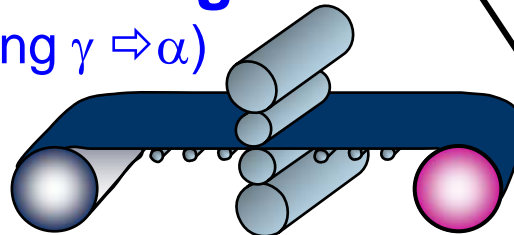
Stauchung

Simulation des Haspelns

Halbwarmumformung

(nach Umwandlung $\gamma \Rightarrow \alpha$)

(PonyMILL)

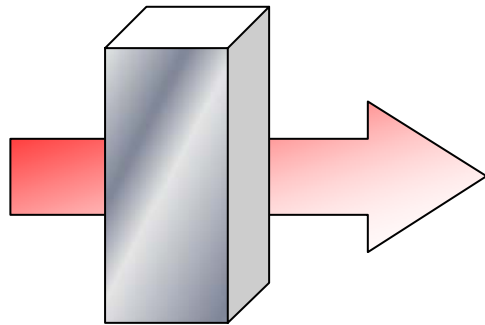


Experimente



bisher:

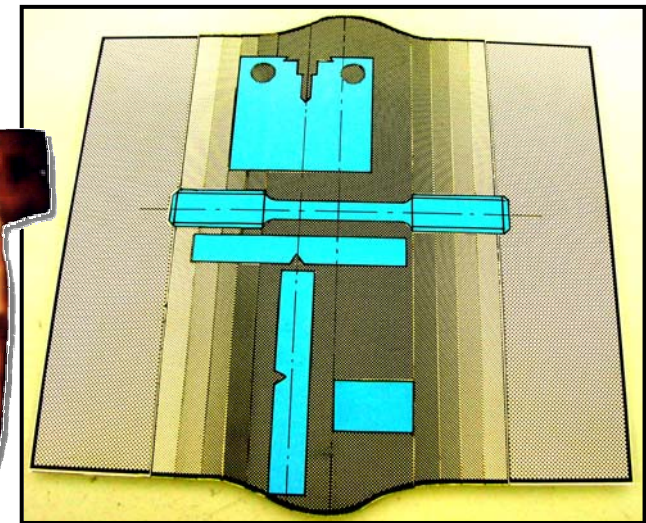
Stauchversuche



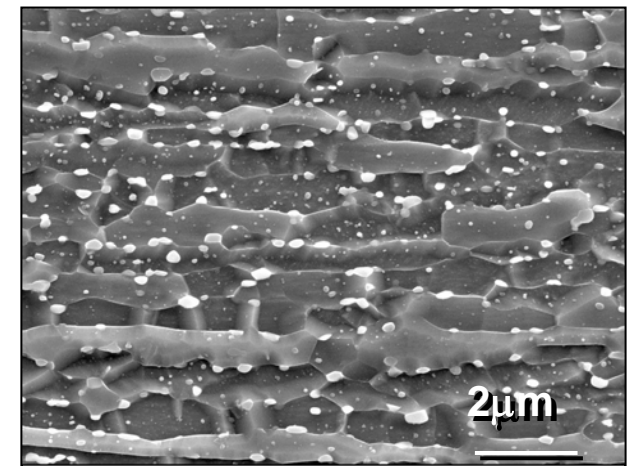
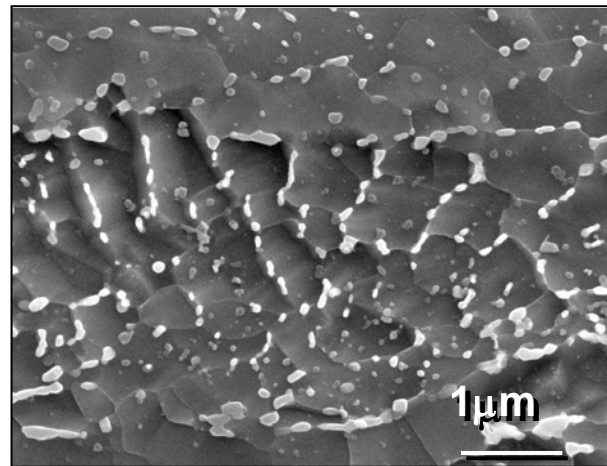
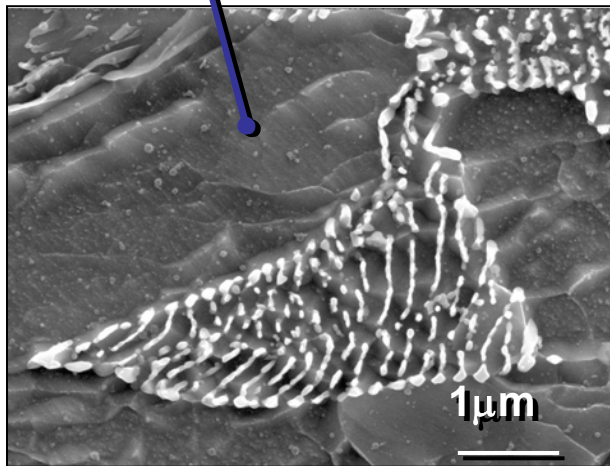
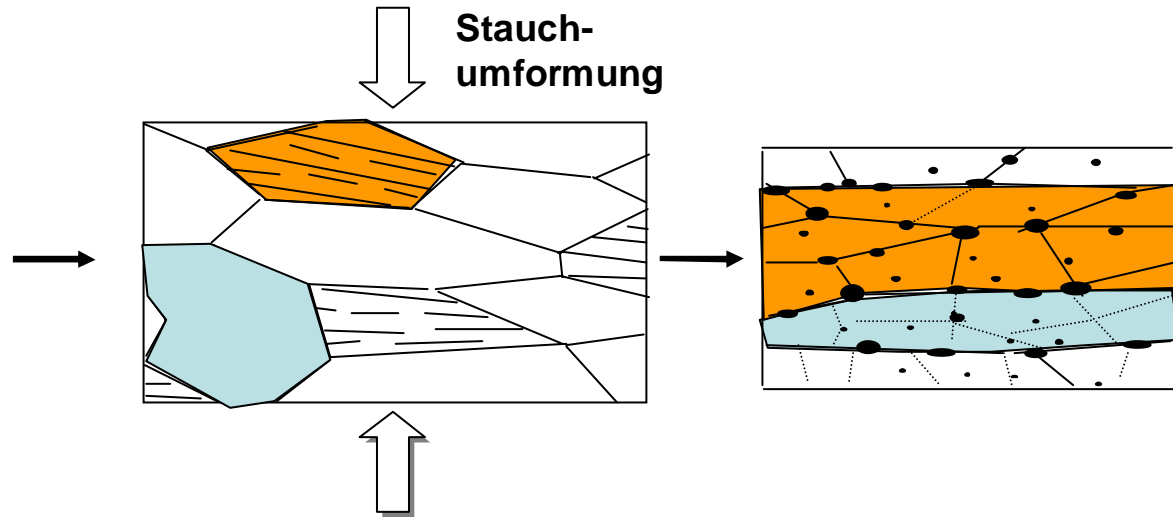
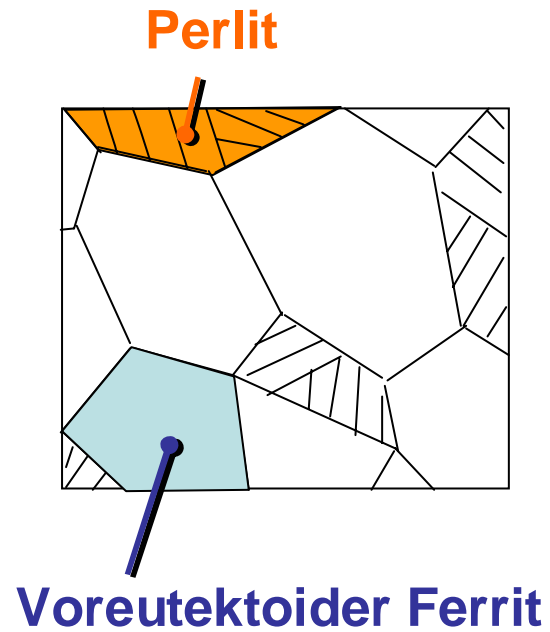
**Gefüge
Härteprüfung**



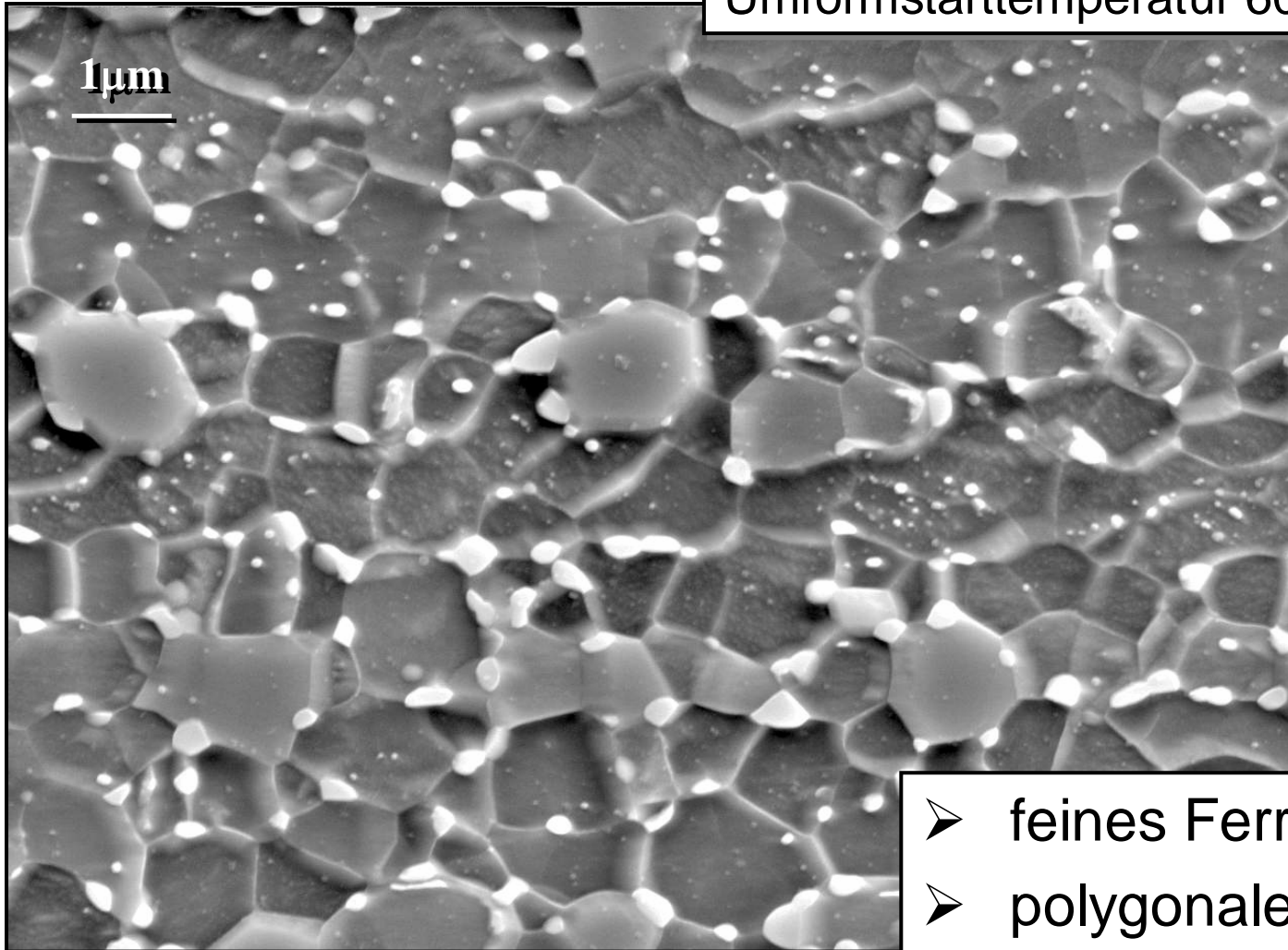
ab 2003:



Gefügeentwicklung während Halbwarmumformung (Perlit-Route)



Umformstarttemperatur 600°C

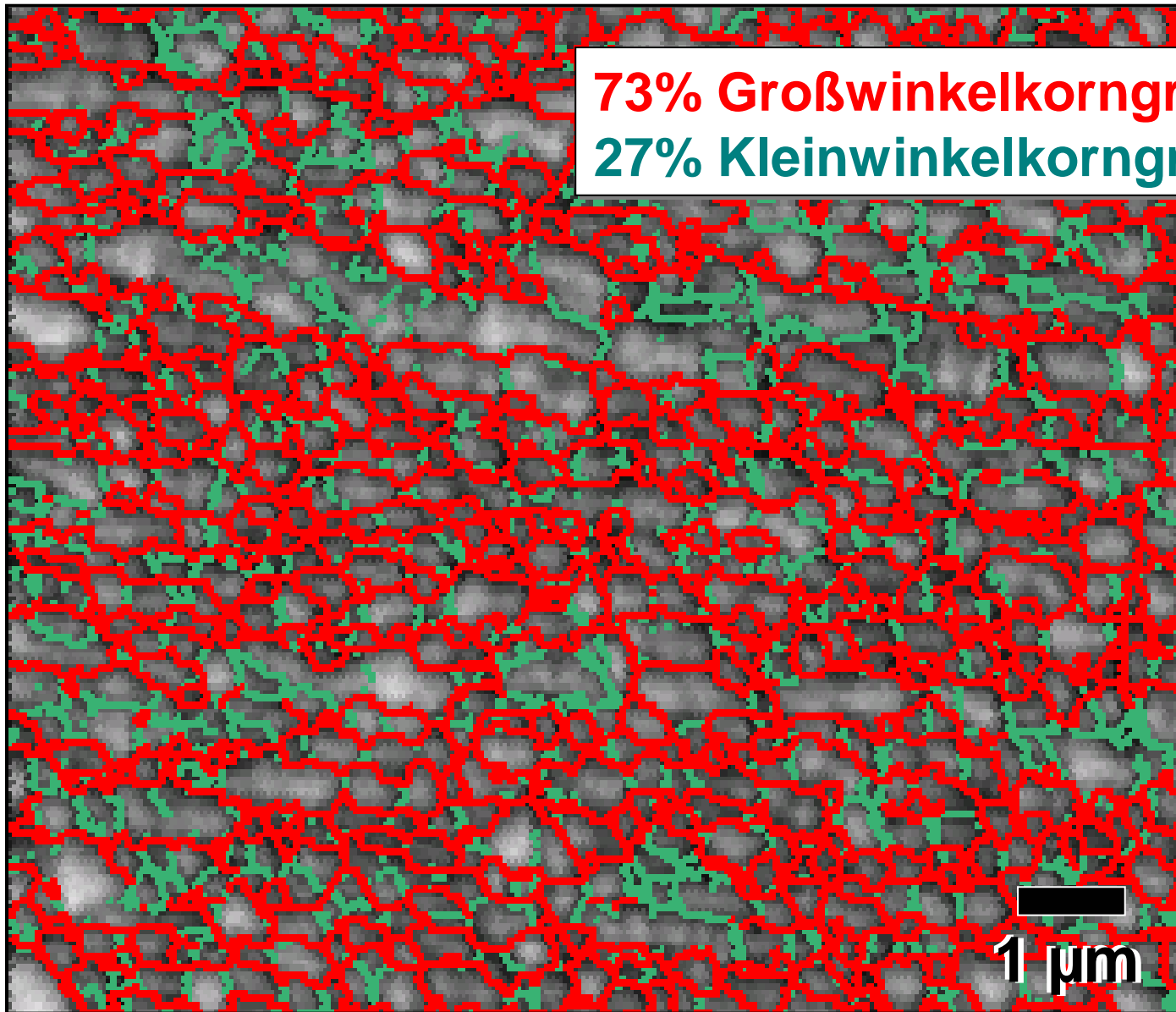


- feines Ferritkorn
- polygonales Ferritkorn
- homogene Verteilung von Zementit

Typische Gefüge

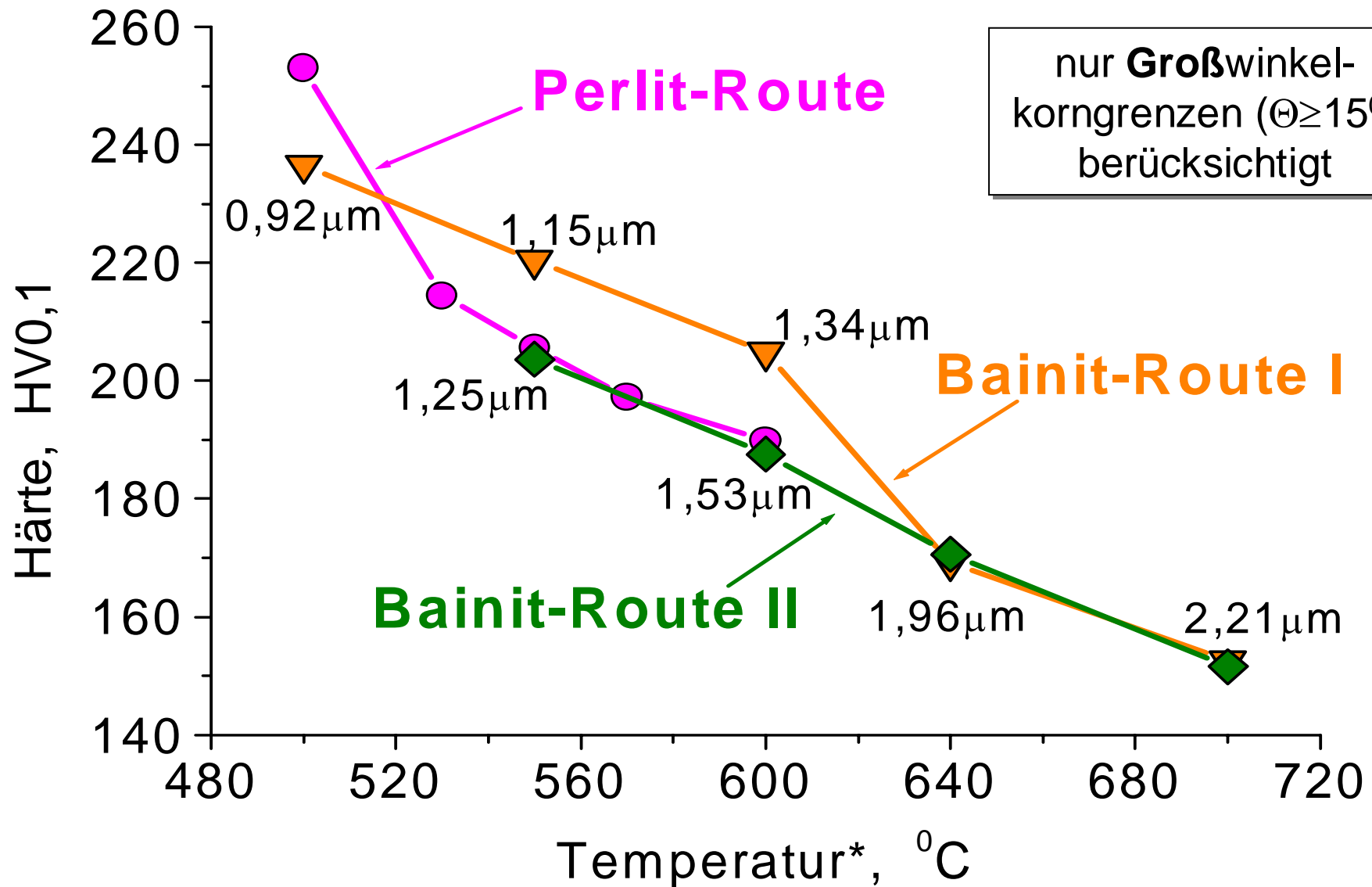


73% Großwinkelkorngrenzen ($\Theta \geq 15^\circ$)
27% Kleinwinkelkorngrenzen ($\Theta < 15^\circ$)



1 μm

Mikrohärte für 3 Routen



* Umformtemperatur (PR and BR II) oder simulierte Haspeltemperatur (BR I)



- Ultrafeines Korn in nicht legierten C-Mn-Stahl ✓
- Feine und homogene Verteilung von Zementit ✓
- Anwendbar für industrielle Produktion ✓