(stress, strain)-curves of minting materials – a basic study

Dr. Gerd Wagner, CEO
Reischauer GmbH,
Idar-Oberstein, Germany

Reischauer GmbH
- technology consulting service -

„Technology of precious-metal blanks and coins“

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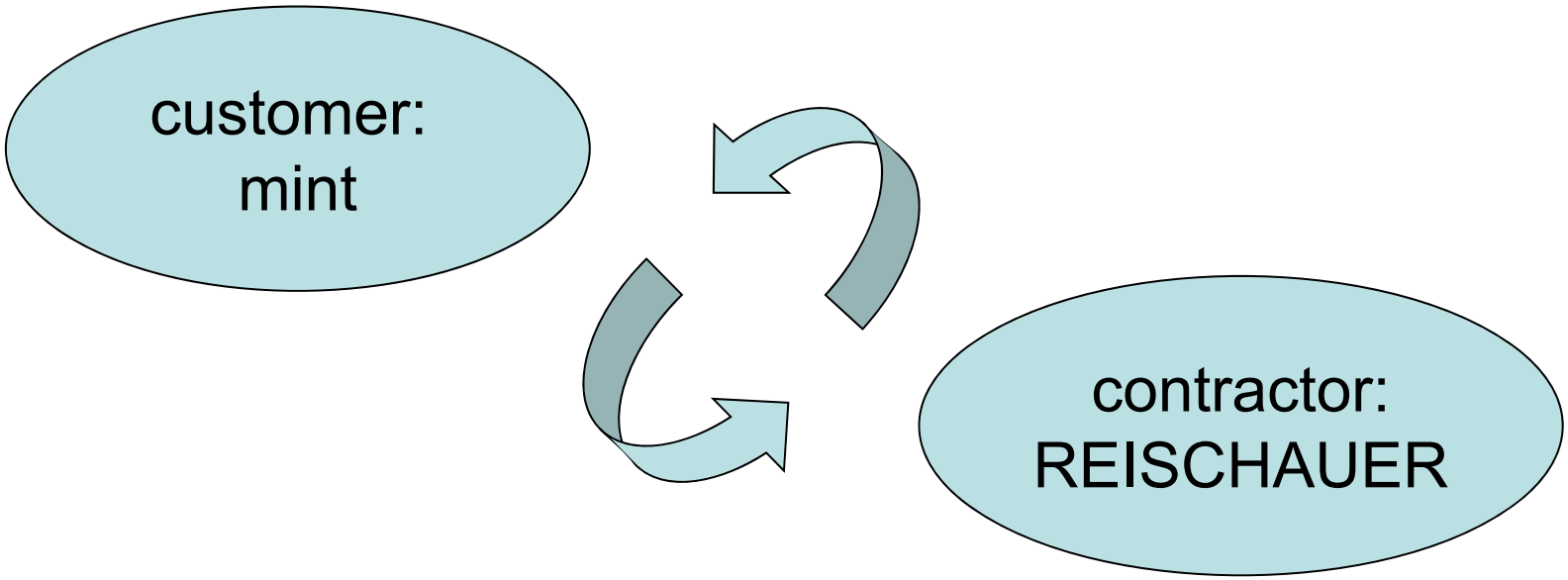
inspection, assessment and improvement of …

- minting materials (gold-, silver-alloys)
- blanks and its manufacturing processes
  - » melting/casting
  - » rolling, annealing, brushing
  - » surface treatment
- minting process
  - » flowing behaviour upon minting
  - » other influencing factors …

Technology consulting service

inspect → assess → improve

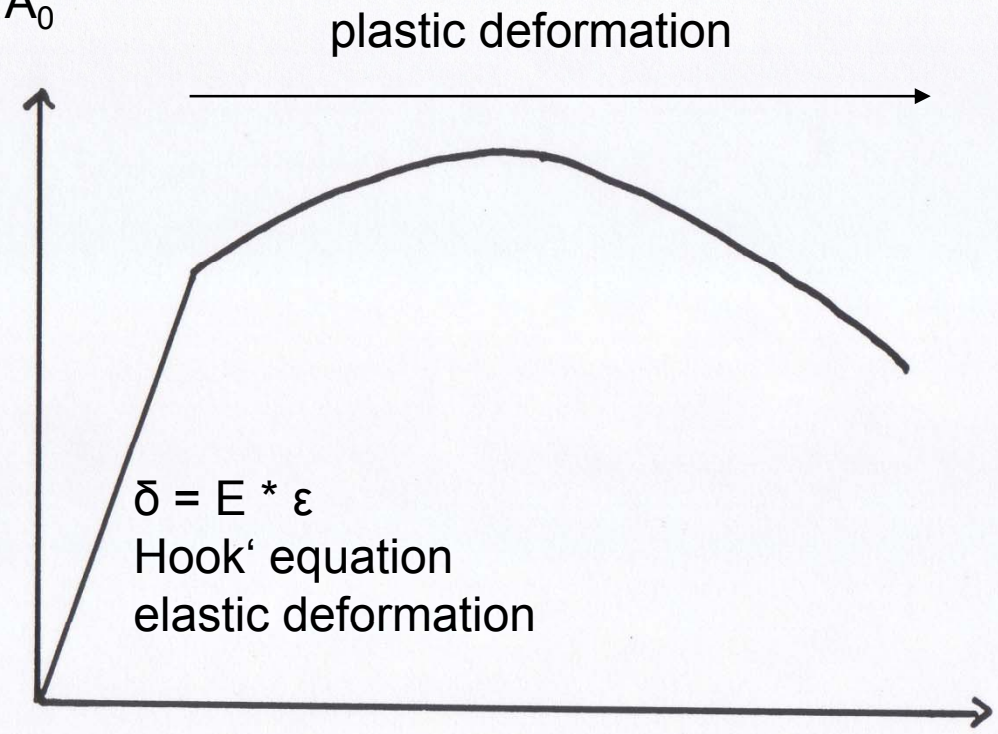



Friedrichsburg 1731

(stress, strain)-curves ?

elongation test

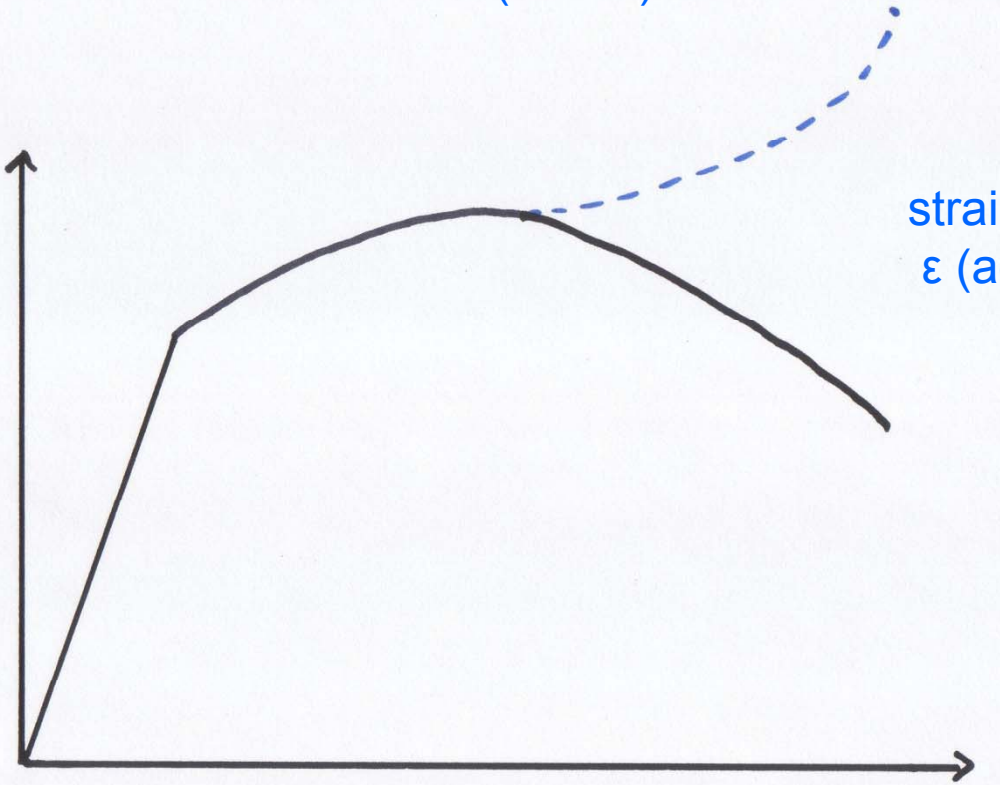
stress:
$\delta = F / A_0$



strain: $\varepsilon = \Delta l / l_0$

elongation test

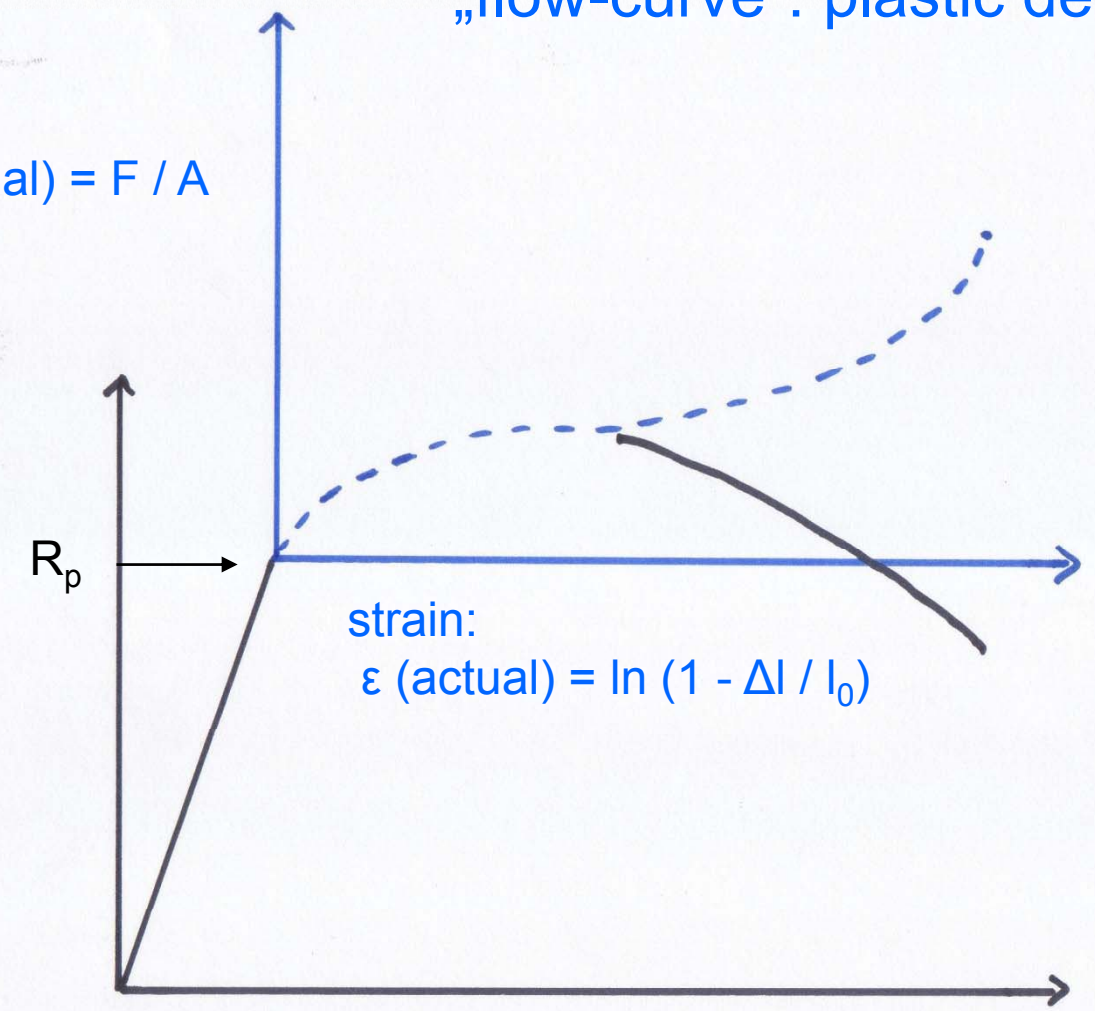
stress:
δ (actual) = F / A



strain:
ε (actual) = ln (1 - Δl / l_0)

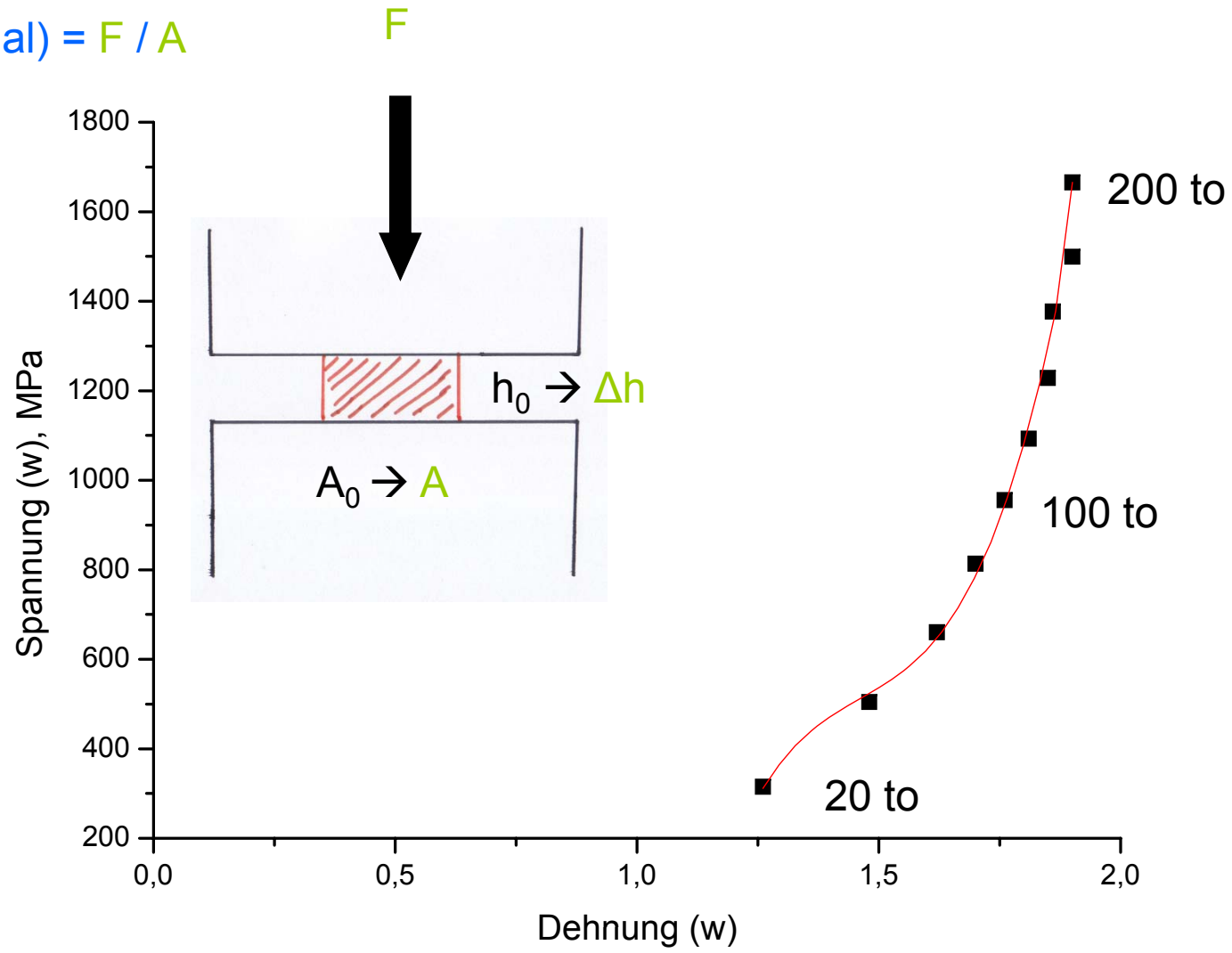
„flow-curve“: plastic deformation

stress:
δ (actual) = F / A



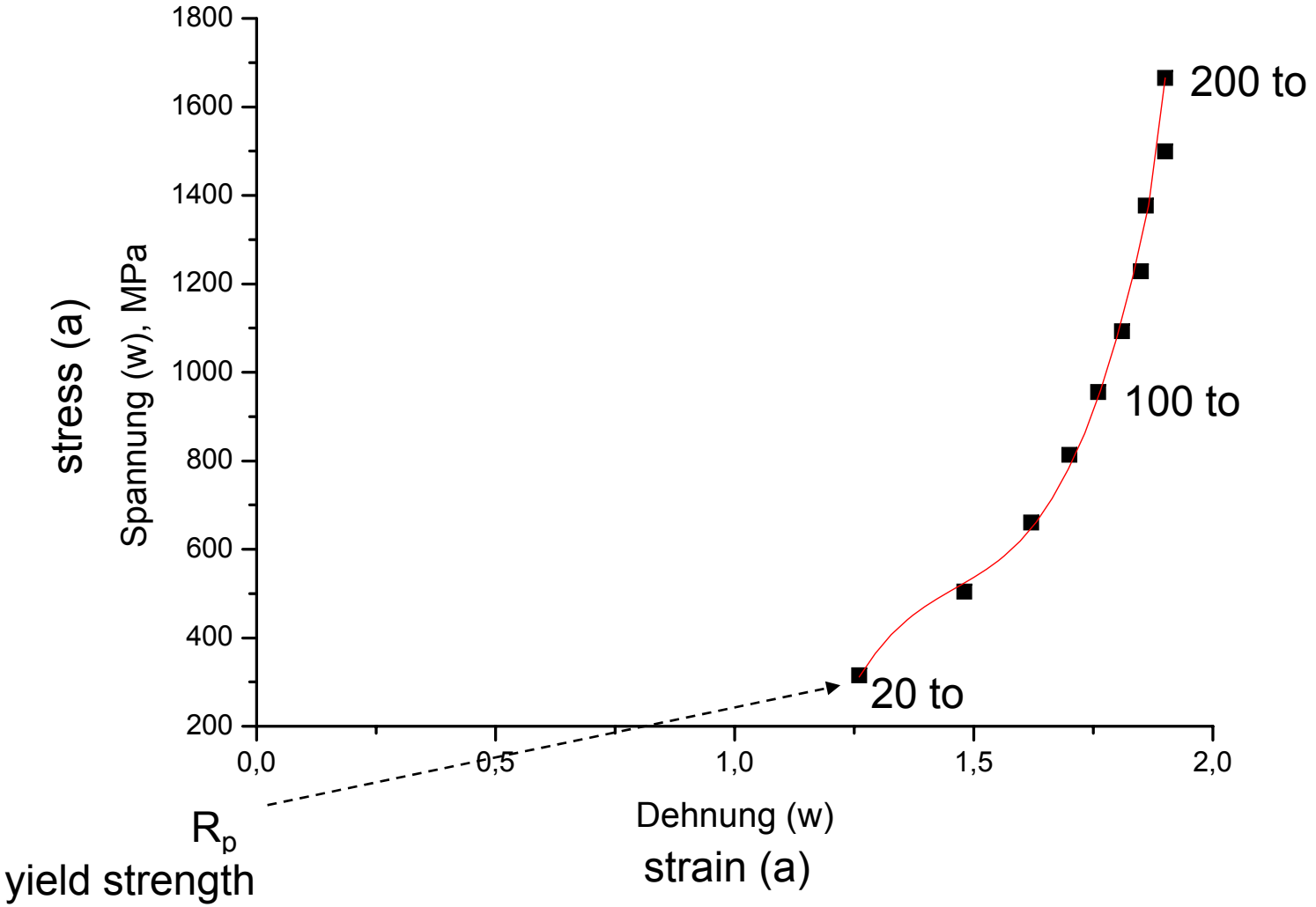
elongation test → compression test -> „flow-curve“

δ (actual) = F / A



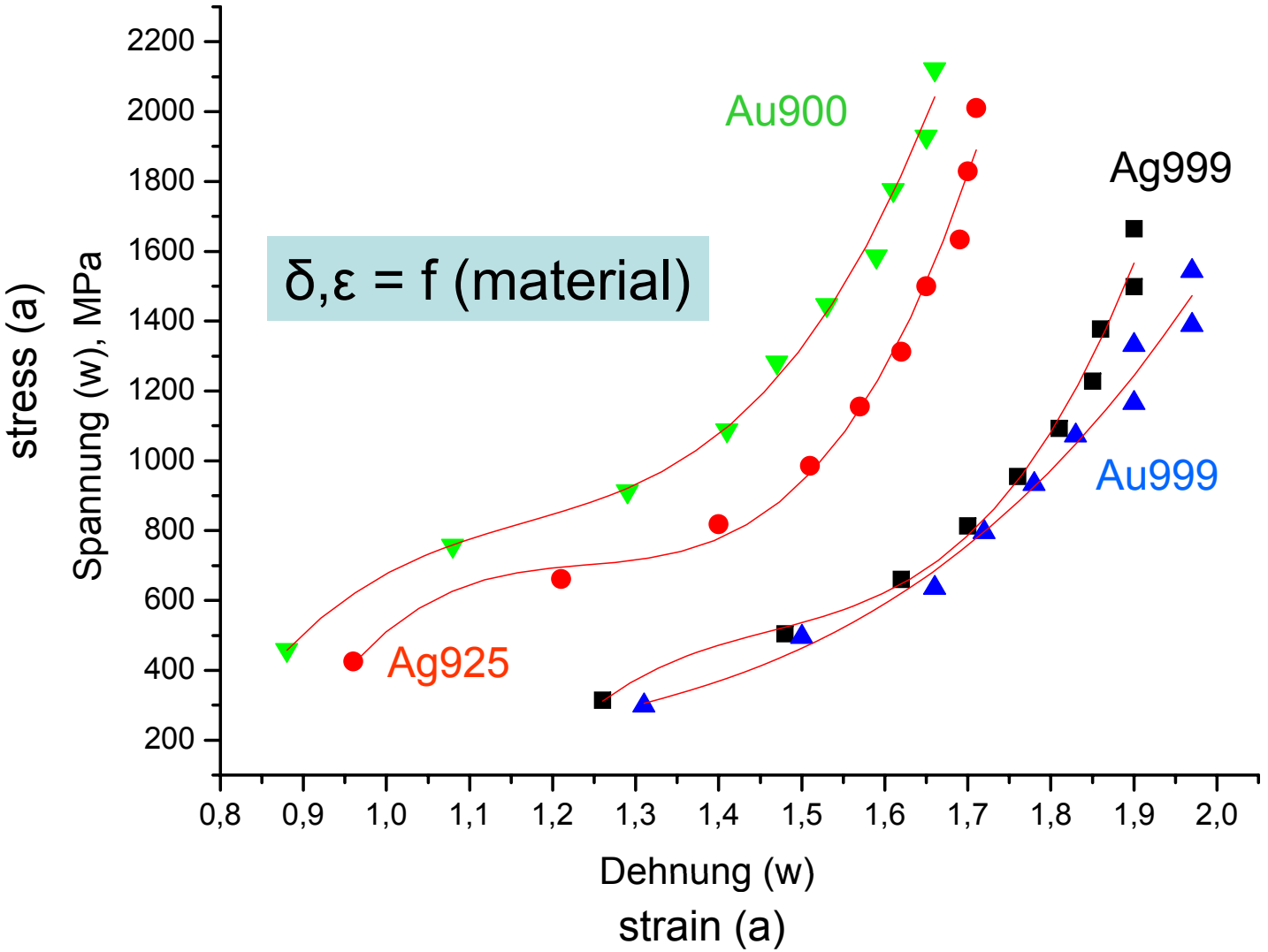
ε (actual) = ln (1 + Δh / h_0)

Ag999 cylinder 15x10 mm



(stress, strain)-curves
or
„flow-curves“
of
minting materials

cylinder 15x10 mm



Ag999 cylinder 20 gr.

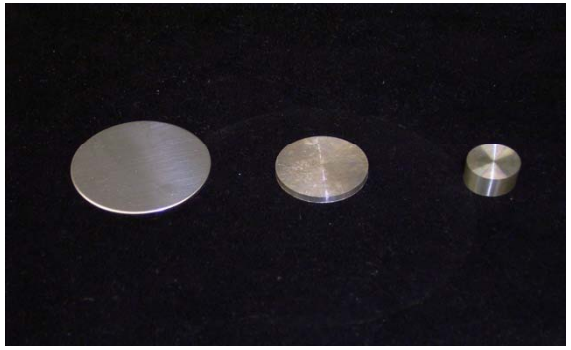
dimensions: „outer diameter / hight“

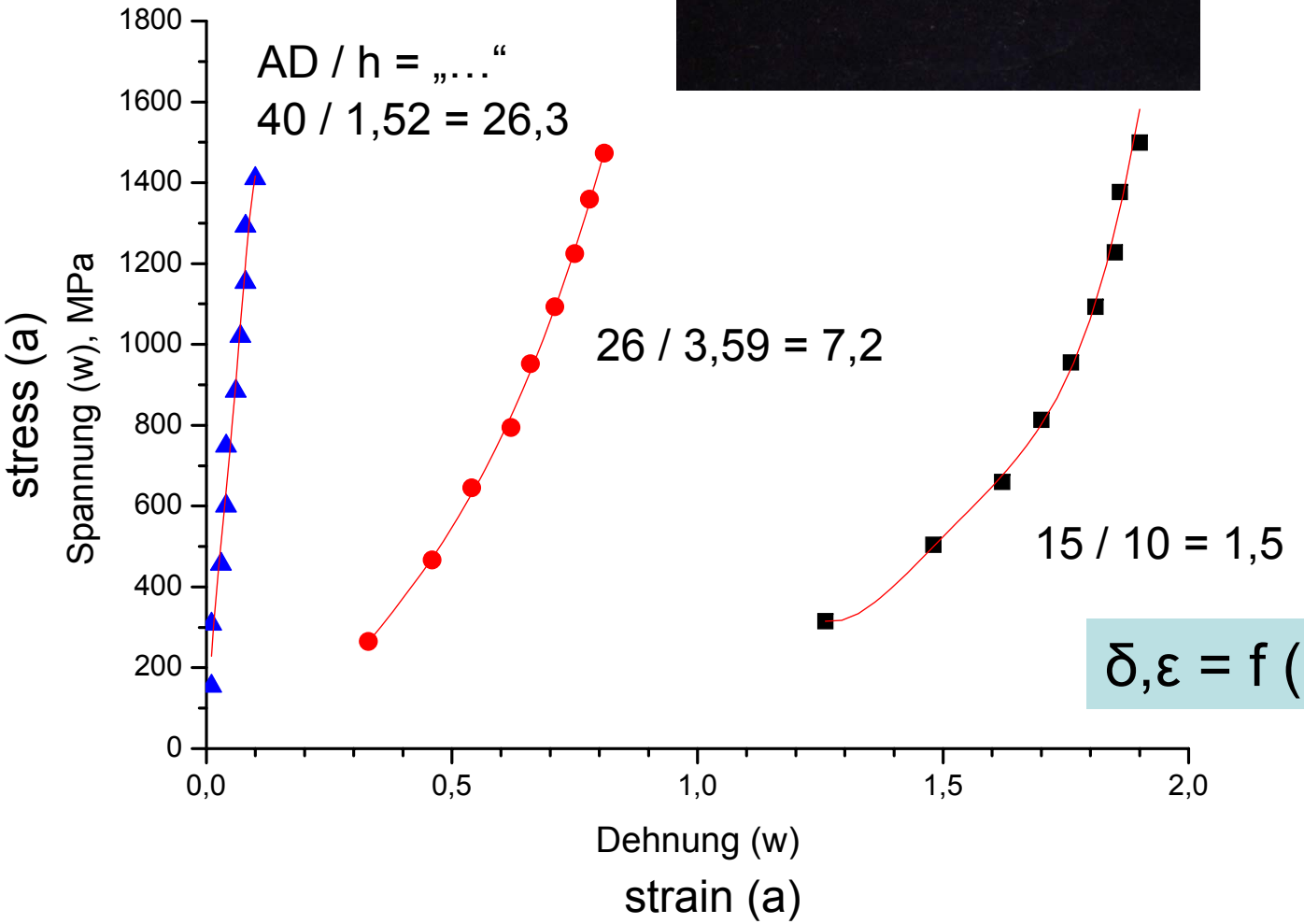
40 / 1,52 = 26,3

26 / 3,59 = 7,2

15 / 10 = 1,5

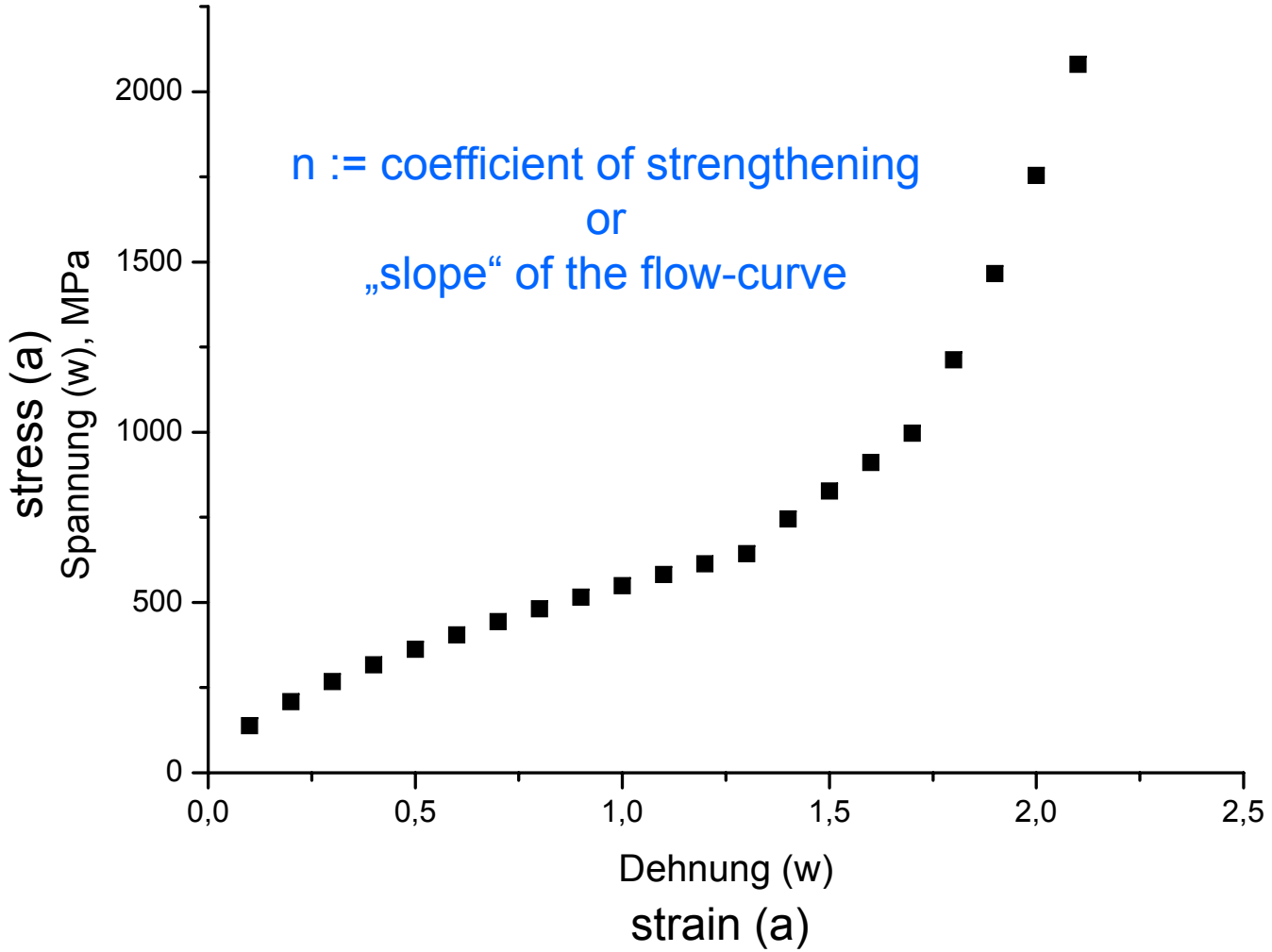
Ag999 cylinder 20gr.



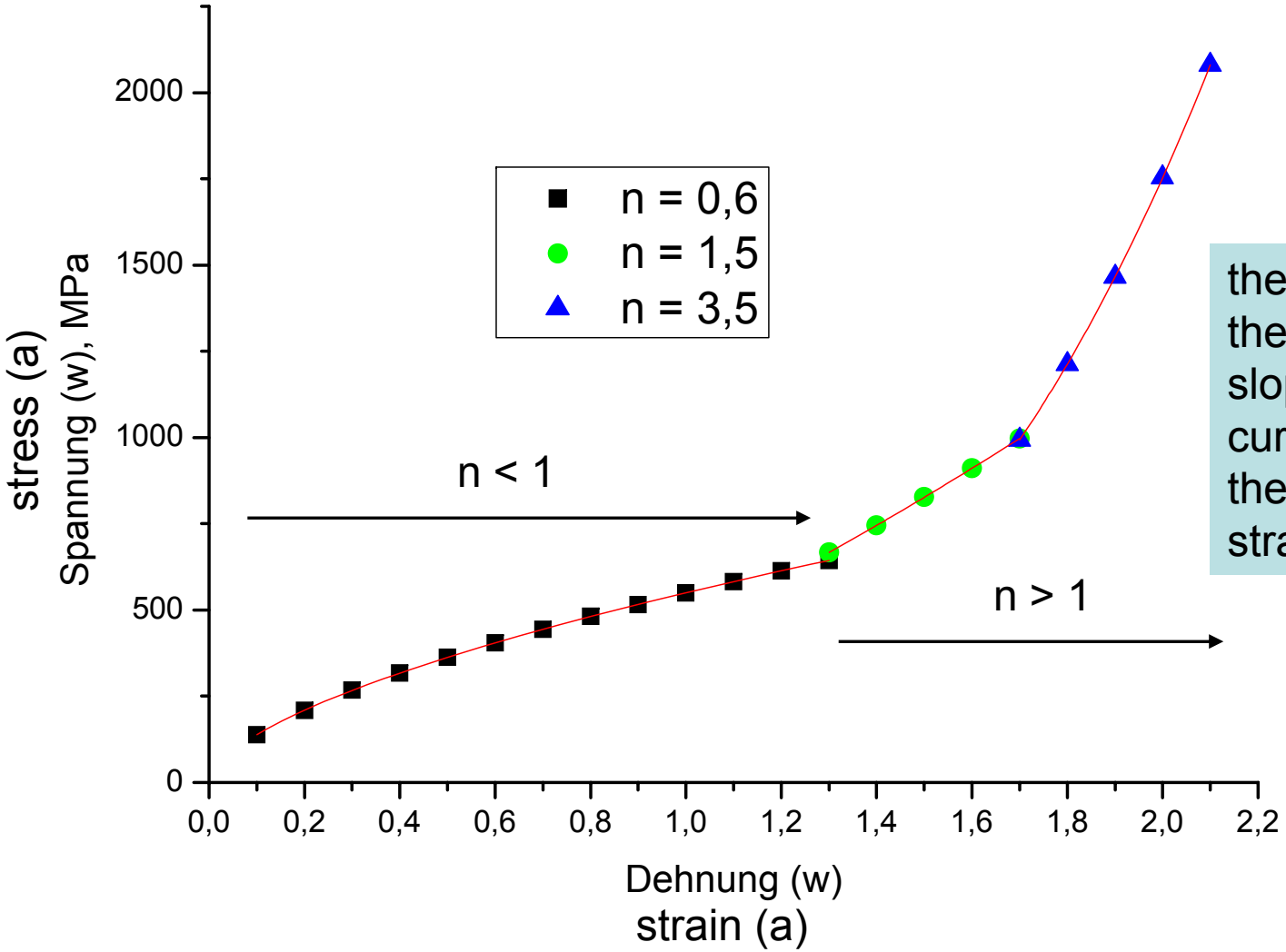


δ,ε = f (dimensions)

„flow-curve“: $\delta = k * \varepsilon^n$

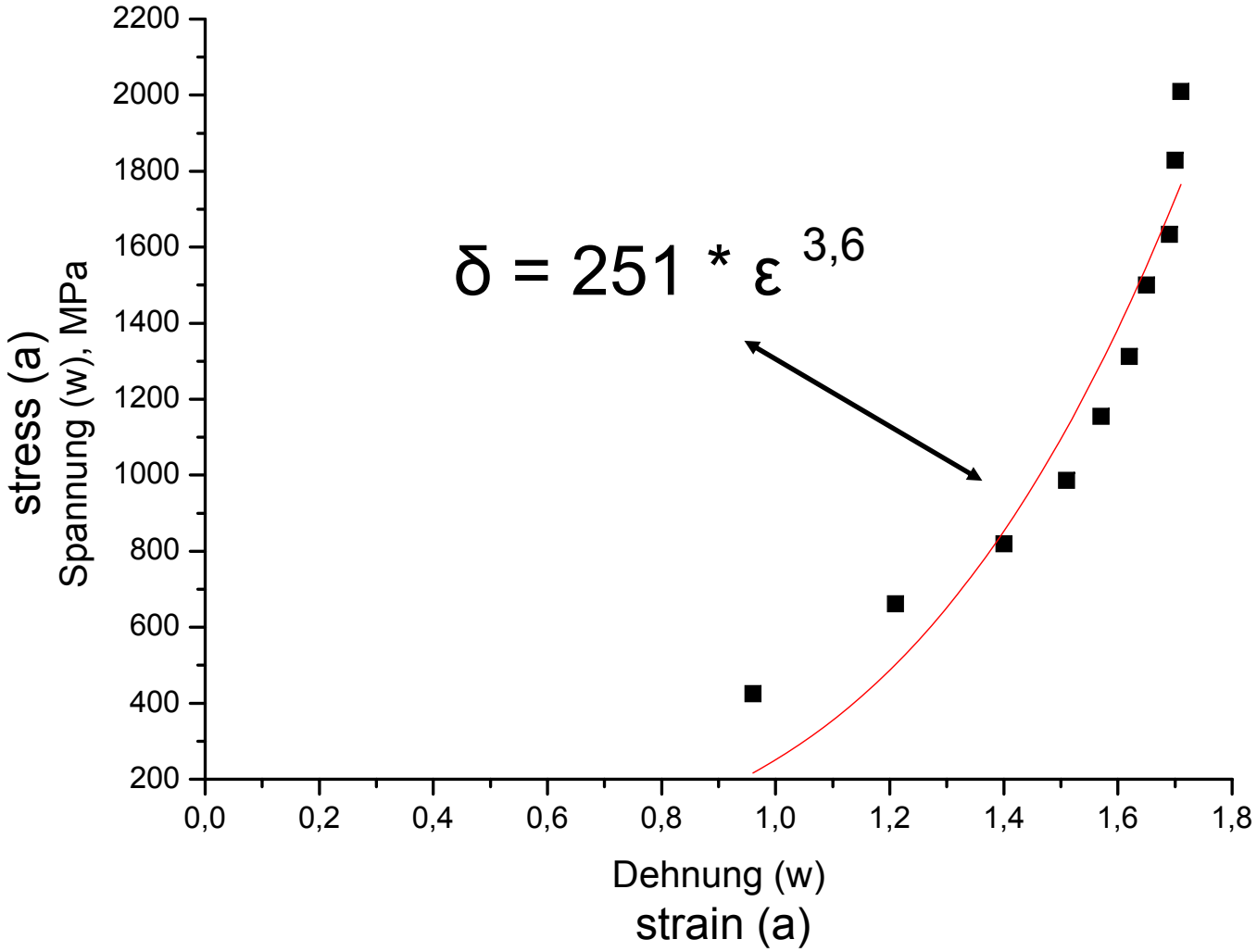


→ „n“ can, but must not be fixed or being a constant !!!

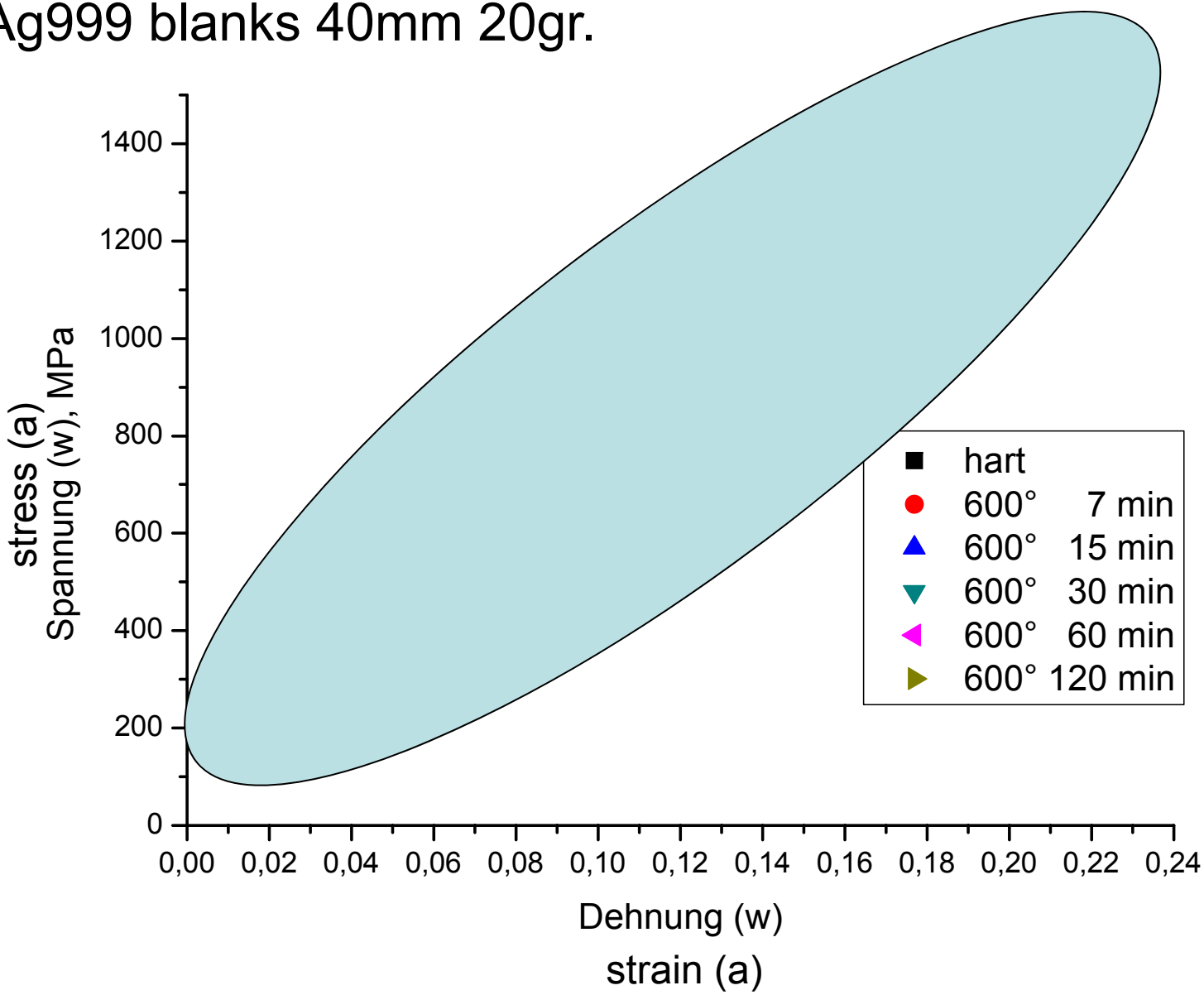


the bigger „n“, the bigger the slope of the flow-curve, the smaller the strain

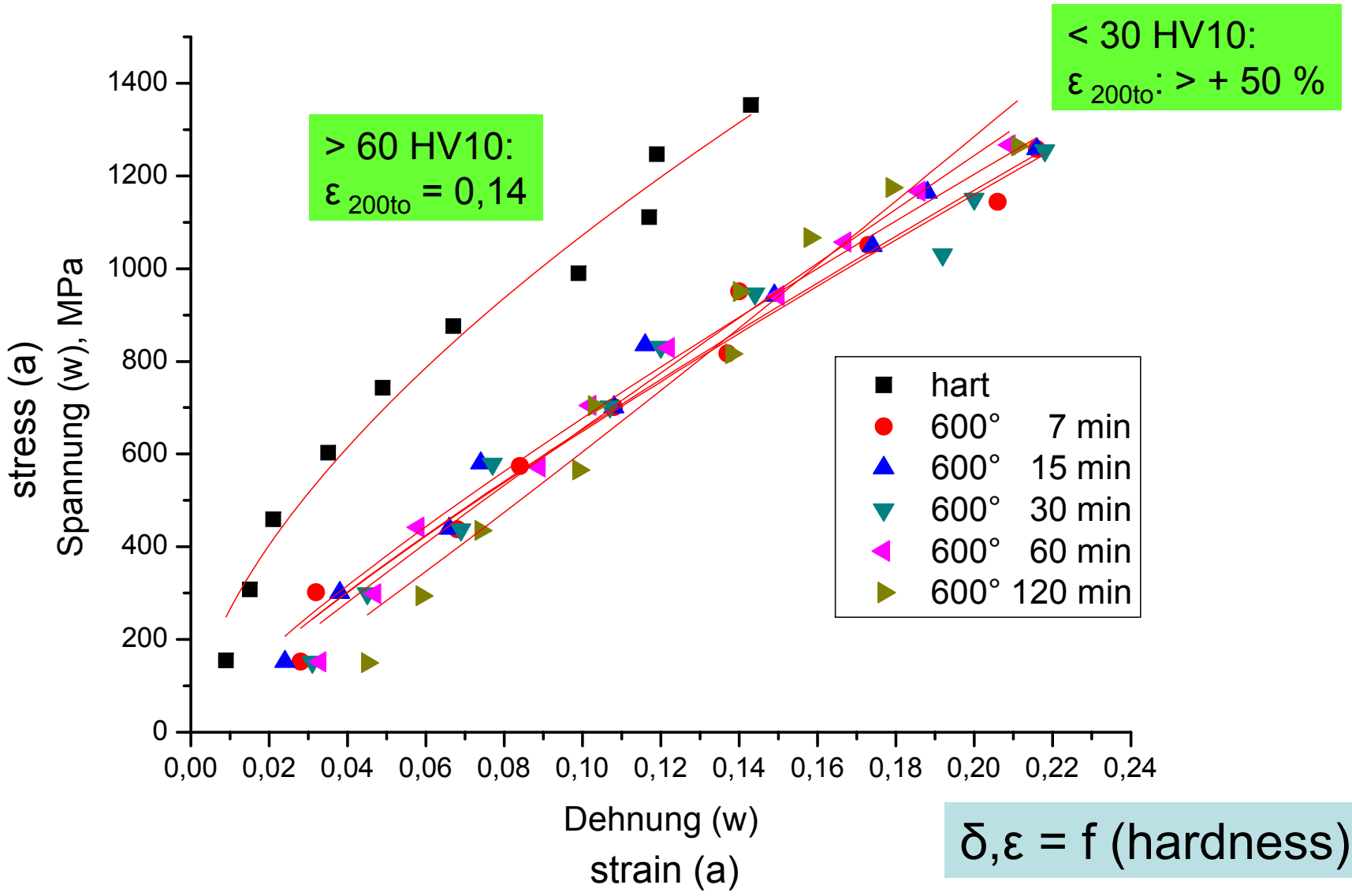
Ag925 cylinder 15x10 mm



Ag999 blanks 40mm 20gr.

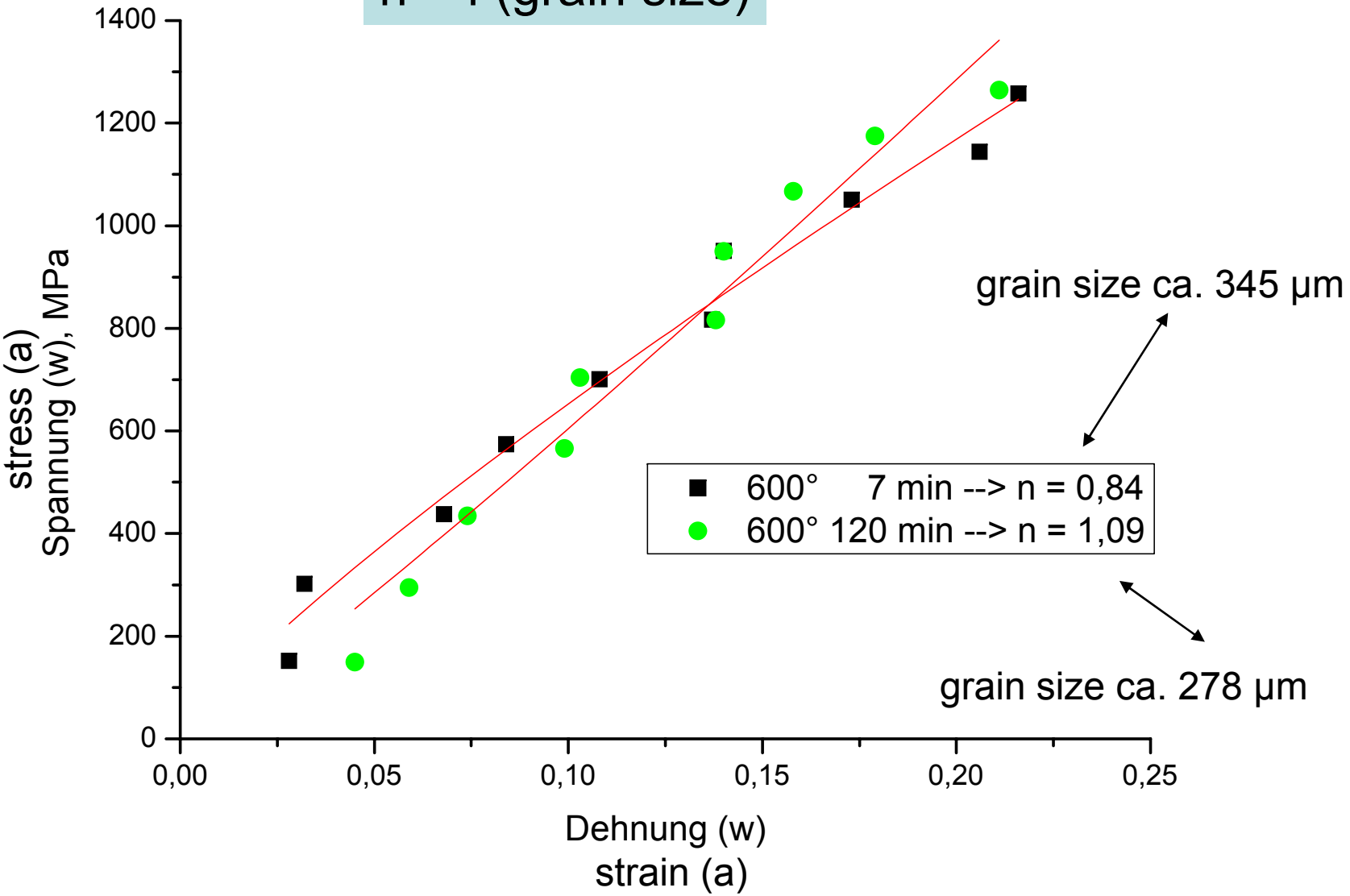


Ag999 blanks 40mm 20gr.

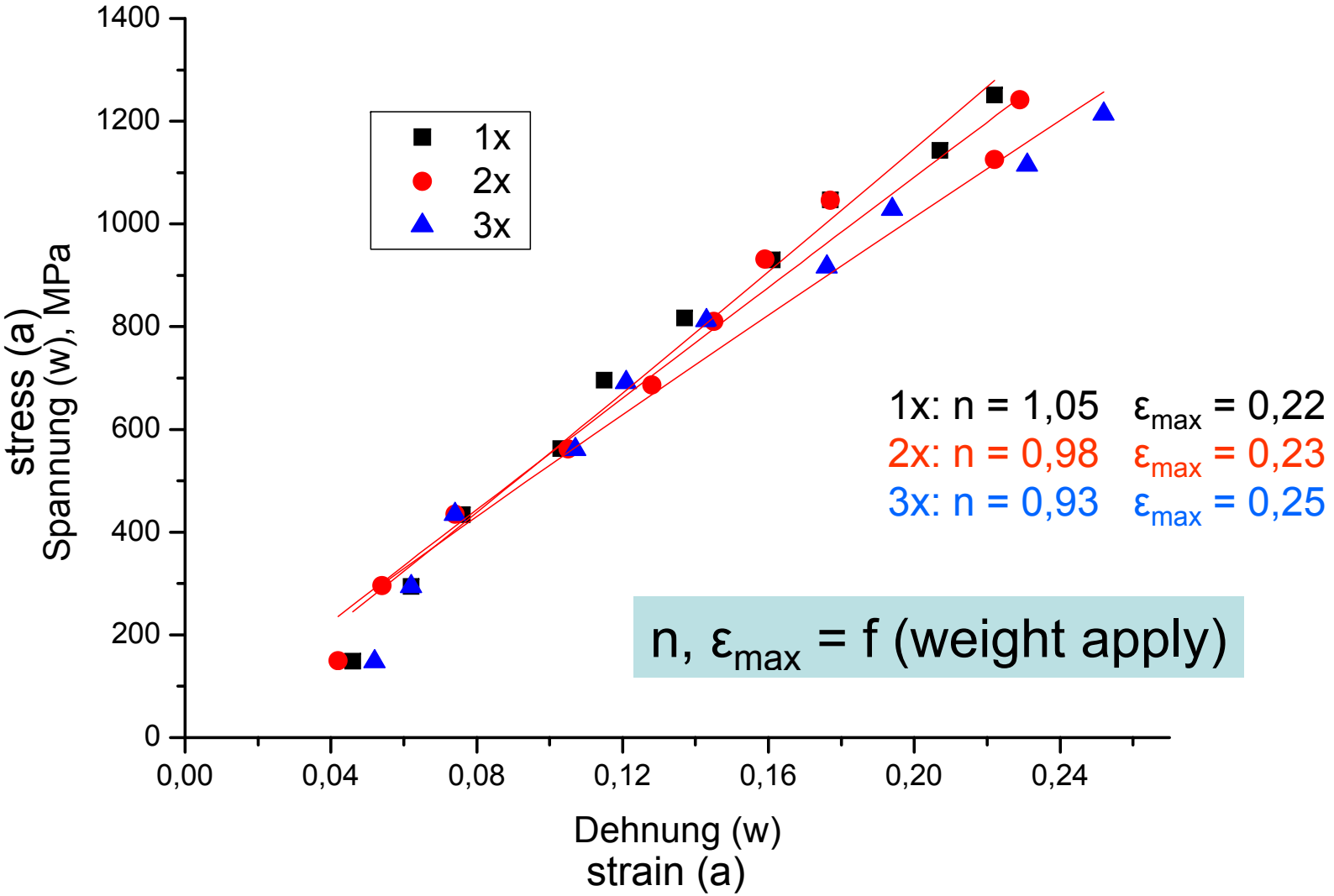


δ,ε = f (hardness)

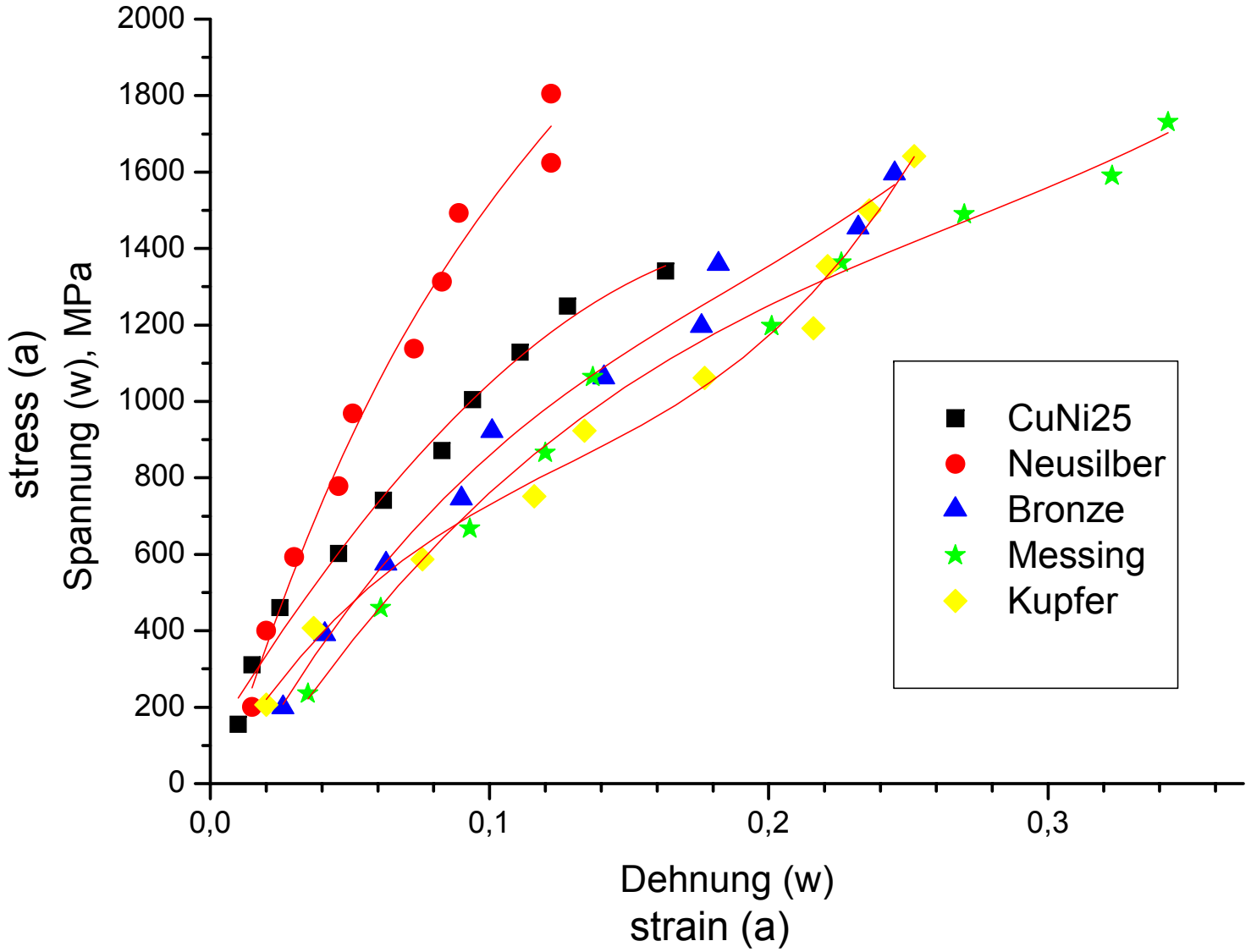
n = f (grain size)



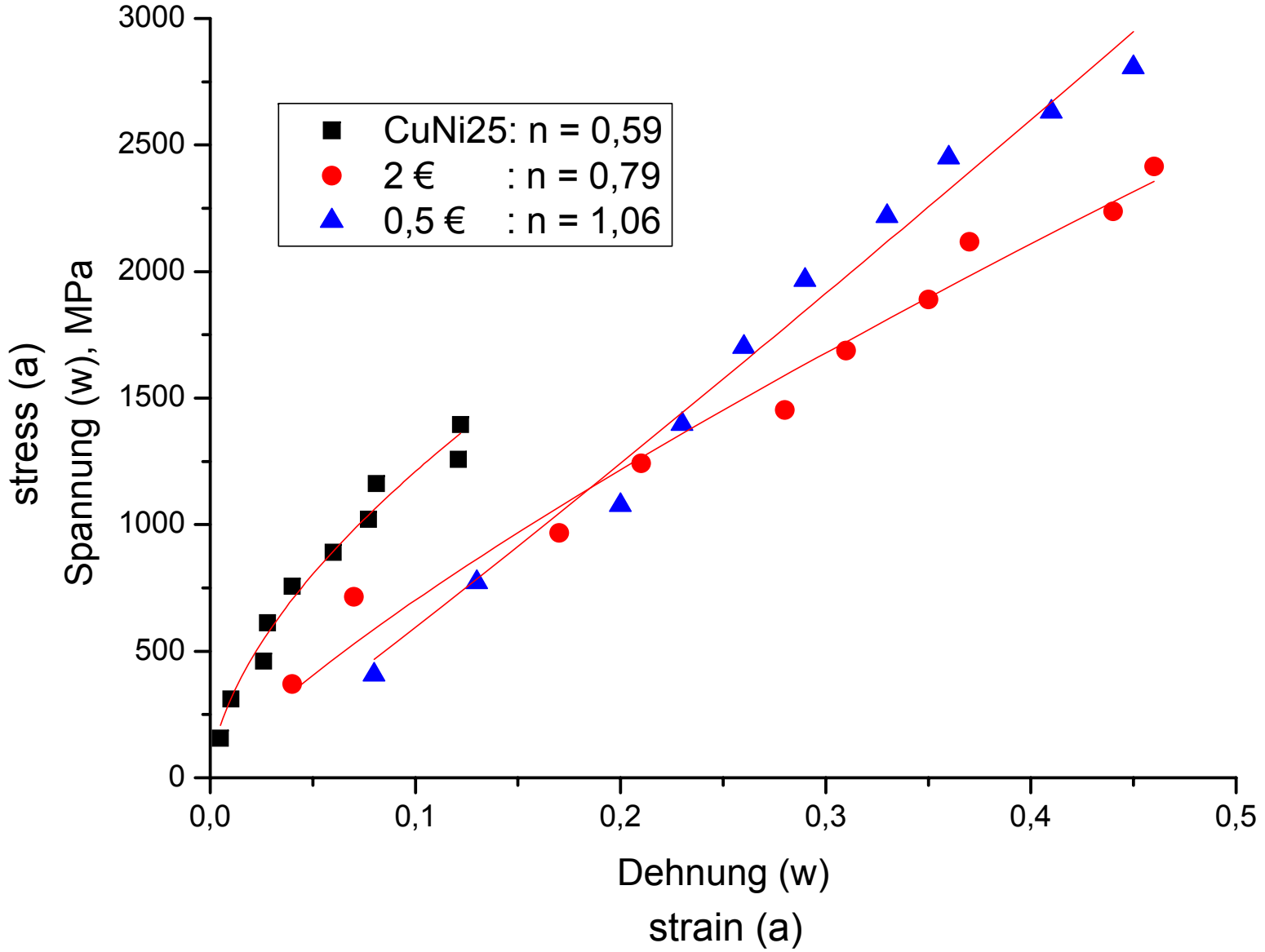
Ag999 40mm 20gr 1,2,3-strokes



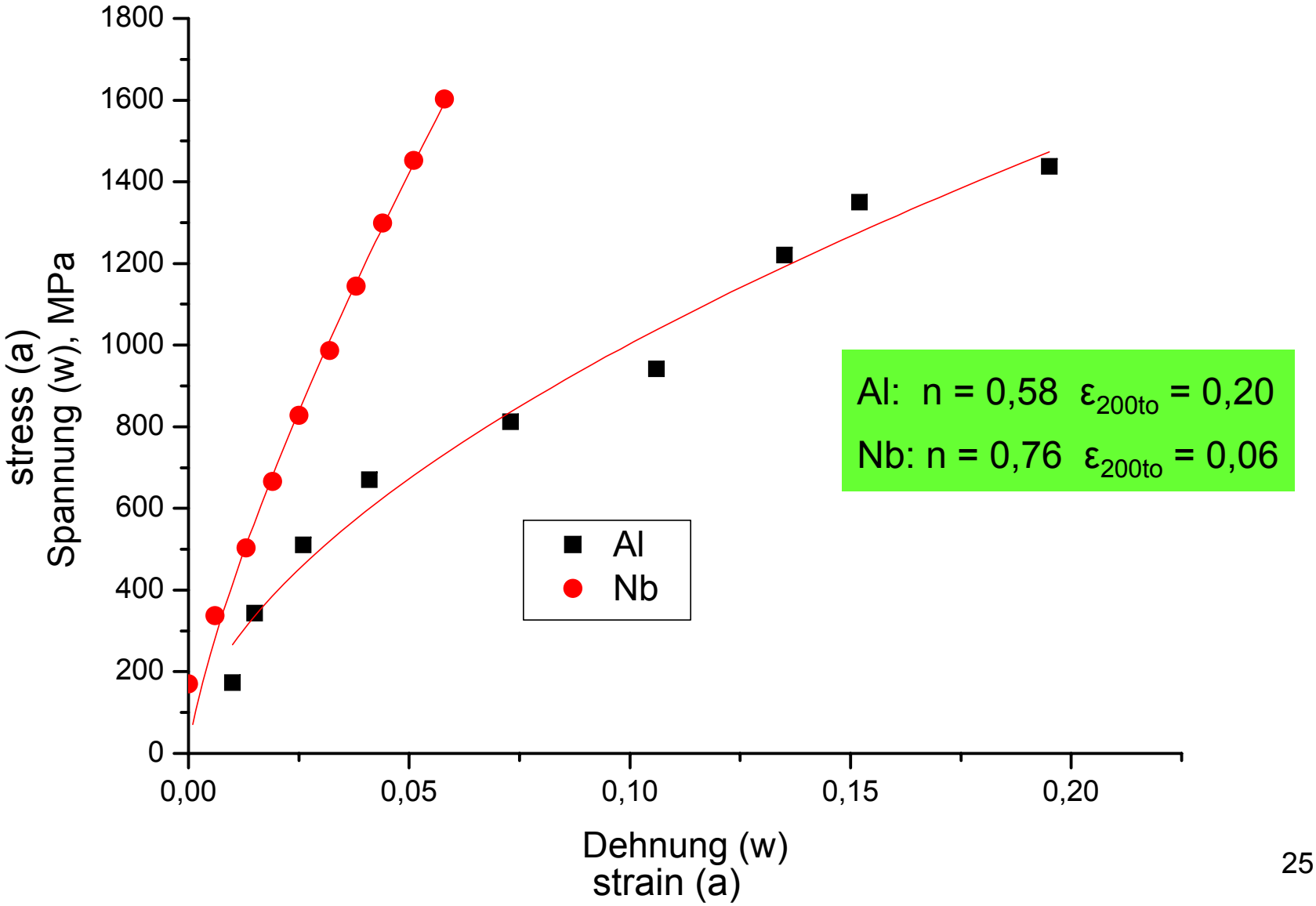
blanks, different Cu-materials and dimensions



€ - blanks, different materials and dimensions



blanks, different materials and dimensions



summary I

The shape of a flow-curve depends on different factors:

- material (alloying elements, impurities ?)
- dimensions of the blank
- crystallographic structure (grain size, texture, alloy-phases)
- hardness
- process parameter (number of strokes, … ?)

summary II

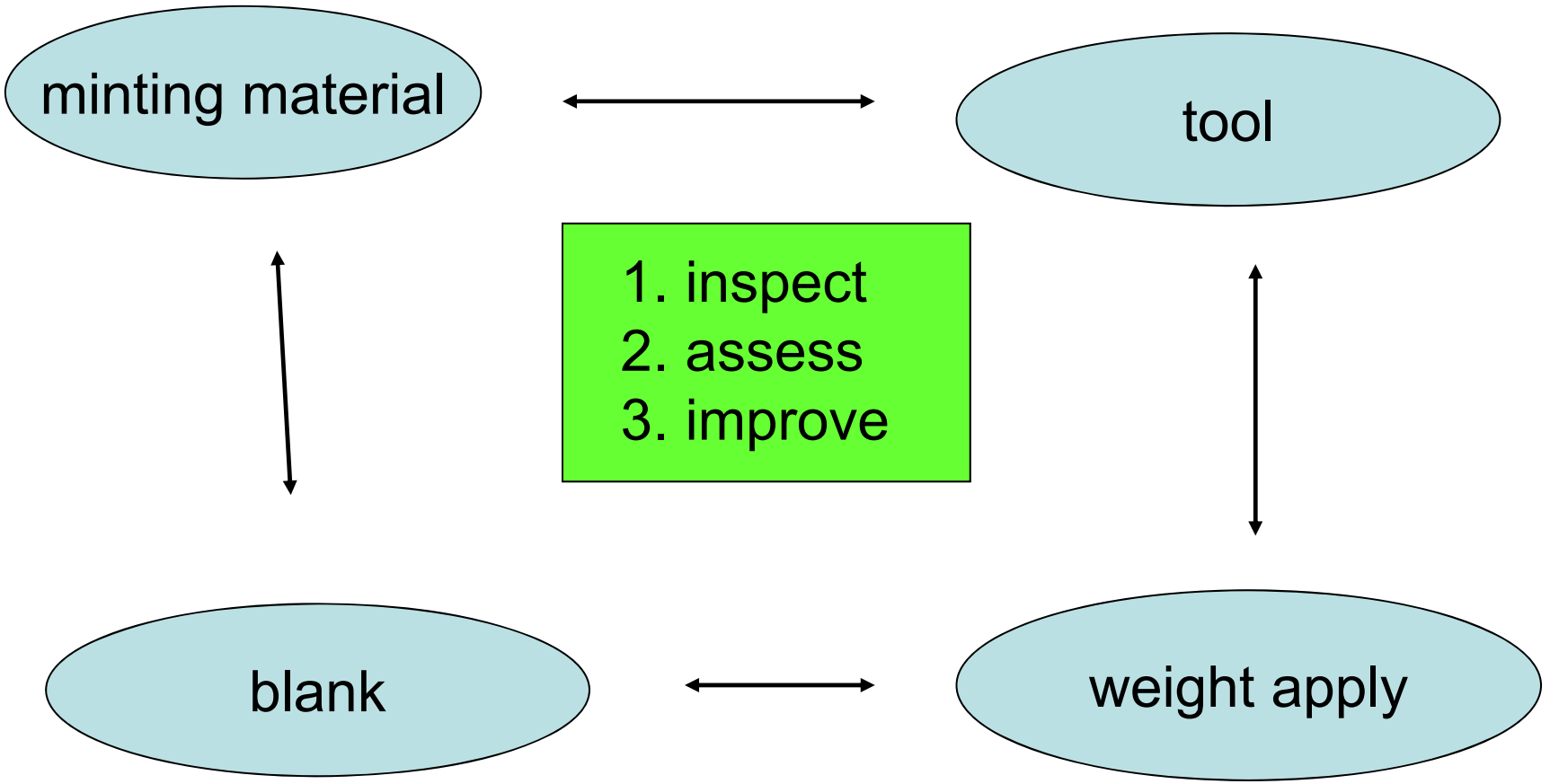
The flow-curve allows to determine the plastic deformation of minting materials upon striking **quantitatively**:

- maximum strain ($\varepsilon_{max,\ x\ to}$),
- coefficient of strengthening (n).

The bigger „$\varepsilon_{max,\ x\ to}$“, the bigger the plastic deformation, ie the potential of flowing upon striking.

The bigger „n“, the bigger the strengthening of the minting material, the smaller the achievable plastic deformation upon striking.

flow-curve: „n“ und „ε_{max}“



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contact address:

Dr. Gerd Wagner
gw@reischauer.de