Influence of Hydrogen Content on Some Properties and Presence of Defects in Zirconium Hydride

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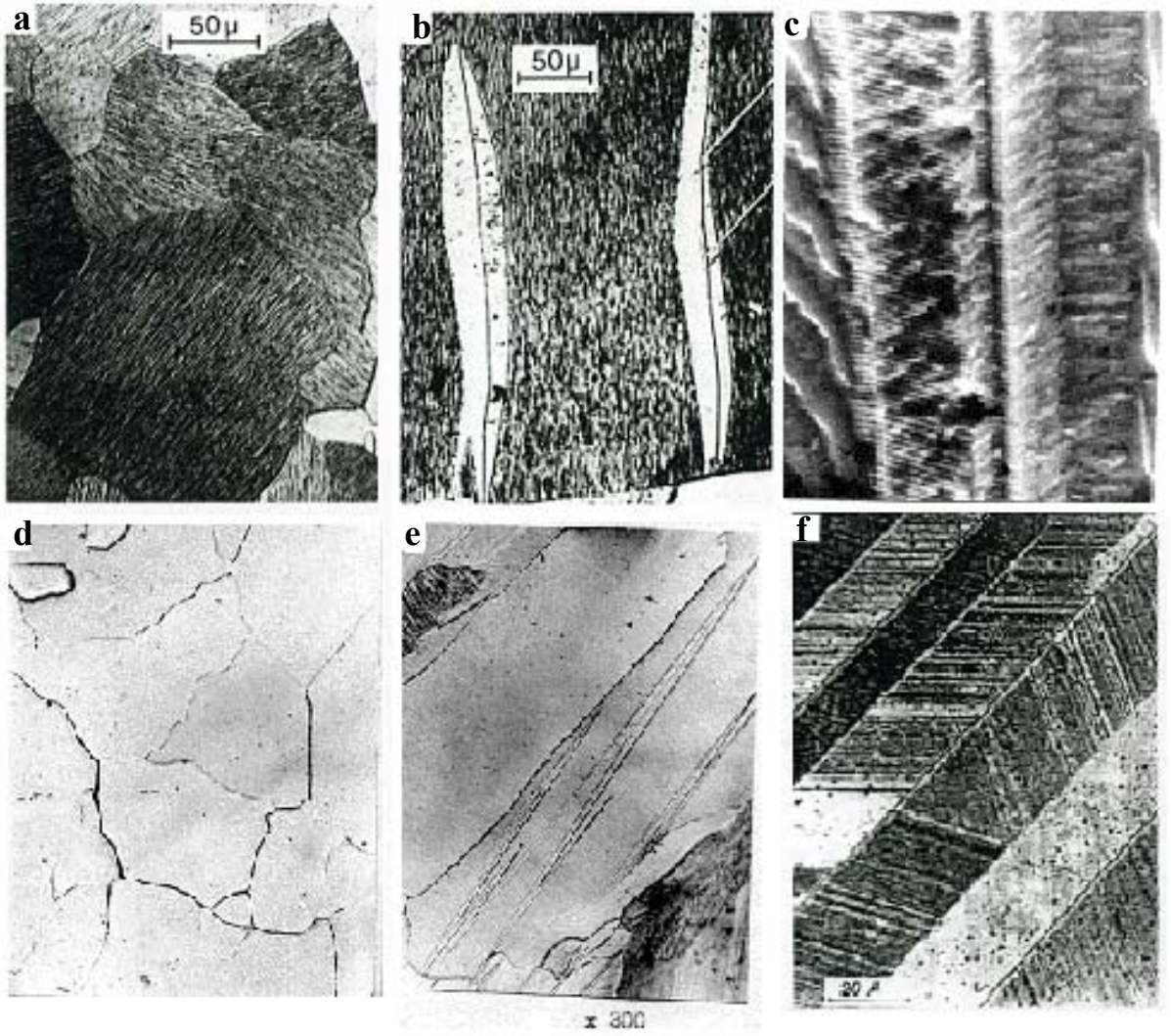
FSUE VNIIA named after N. L. Dukhov, Moscow

Zirconium hydride structures depending on hydrogen content **1**



δ - phase
$ZrH_{1.66}$

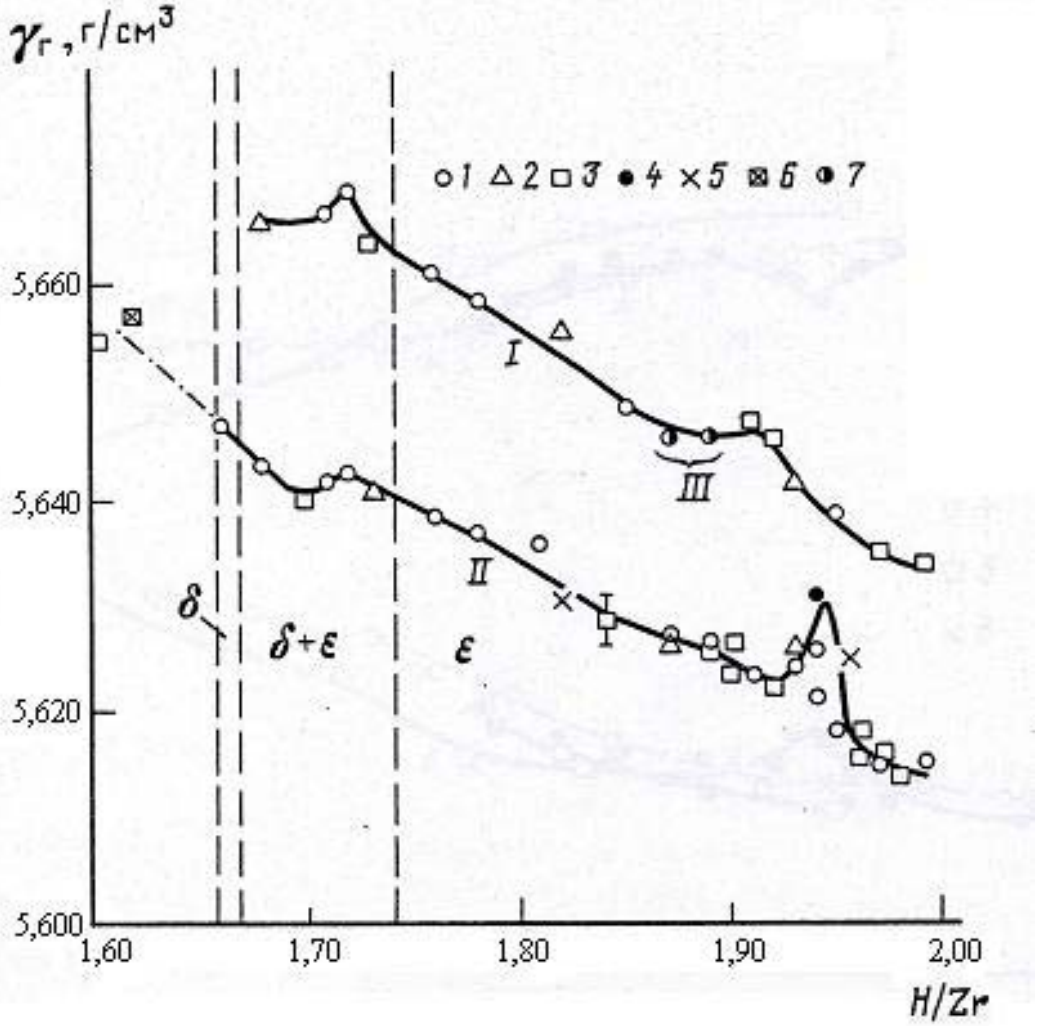
δ +ε - phases
$ZrH_{1.66\text{-}1.67}$

ε- phase
$ZrH_{1.93}$

Concentration dependences of hydrostatic density of zirconium hydride samples

(I- doped zirconium 1.1% Nb, 0.07% O (mass.); II – undoped zirconium;

III - 1.1% Nb, 0.01% O **2**



Time elapsed till measurement made after hydrogenation (month)

o - 1,

Δ - 6,

□ - 12,

● - 24,

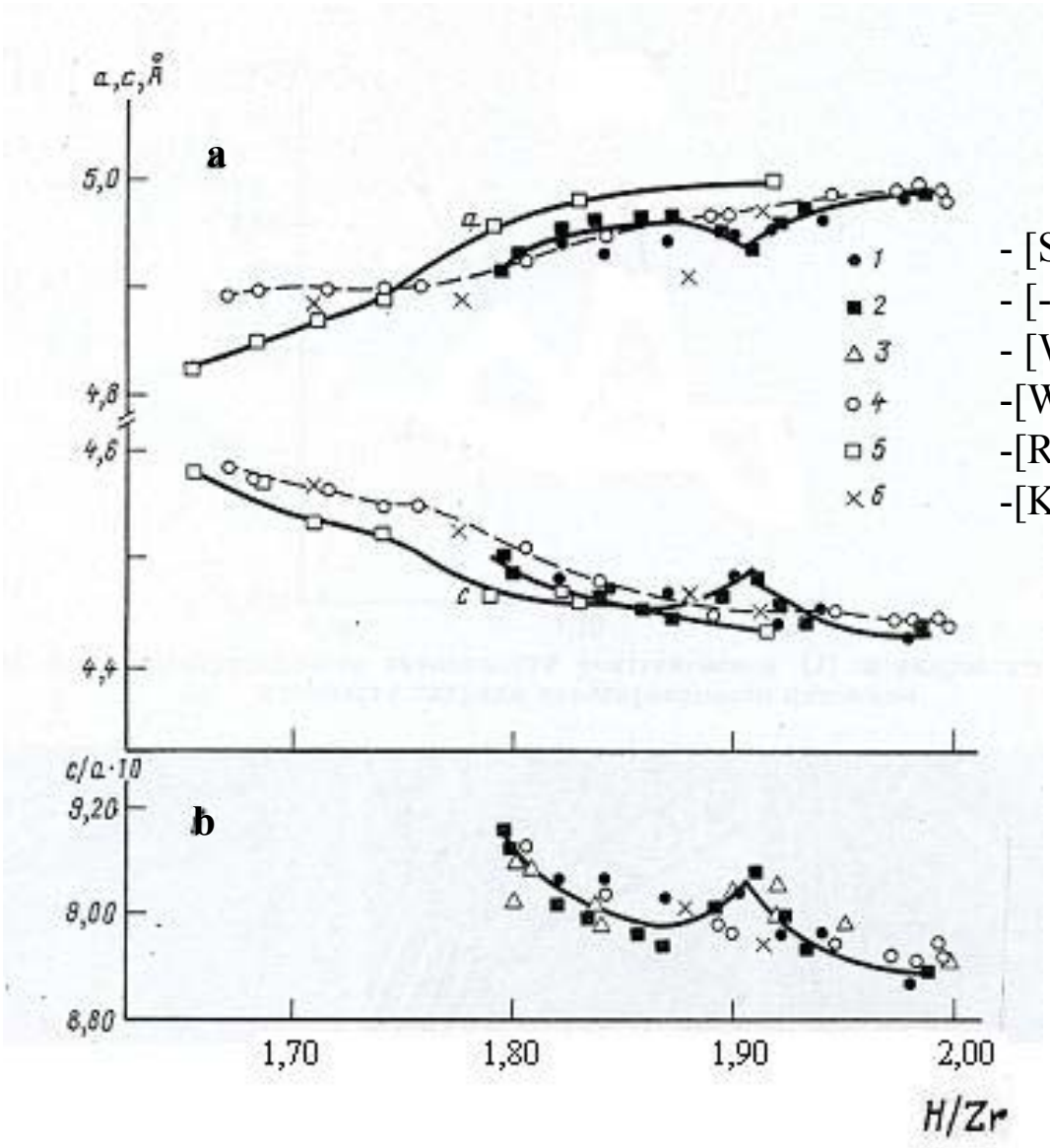
× - 48,

◑ -60,

⊠ -24.

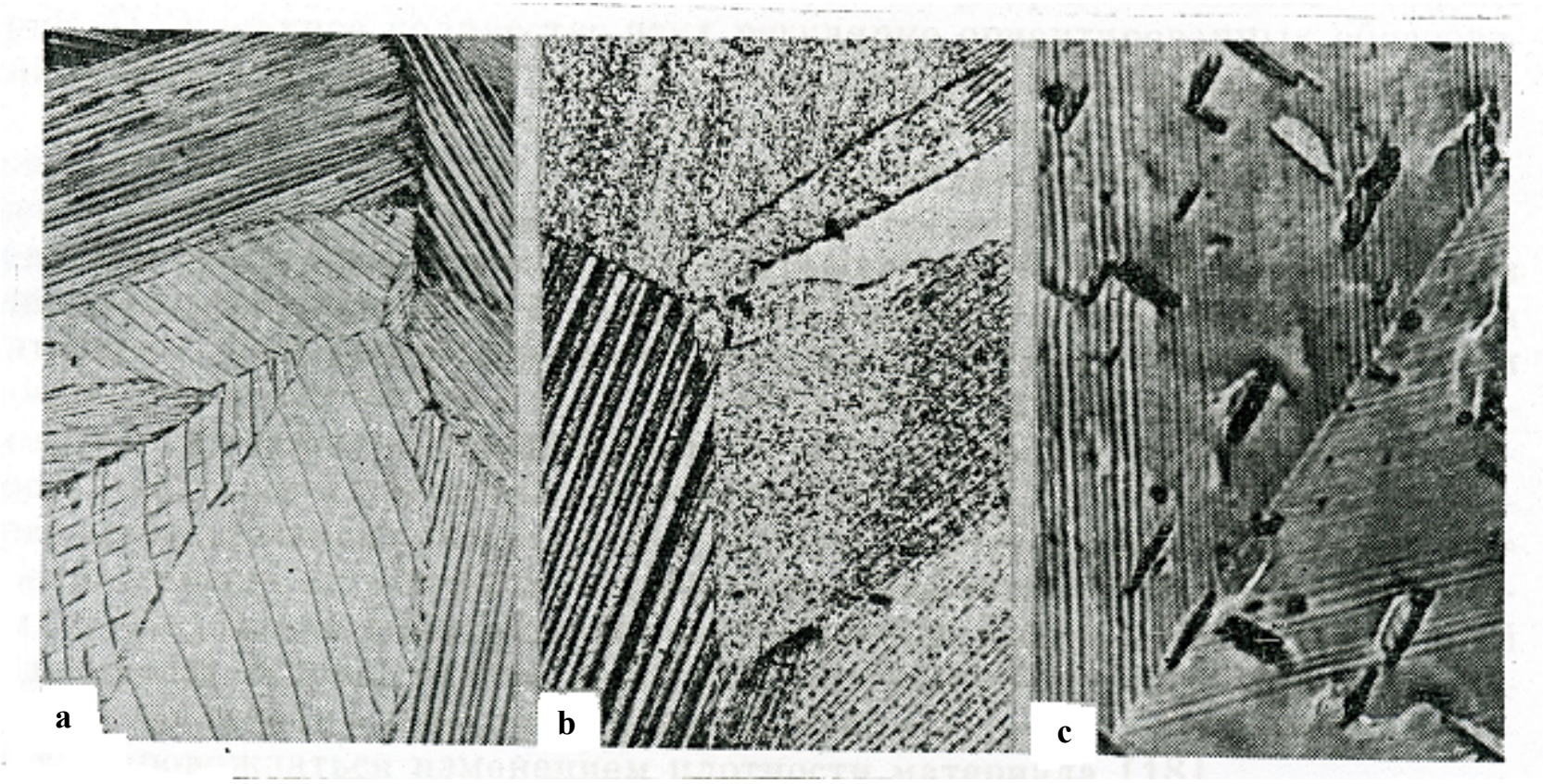
g/cm³

Concentration dependences of crystal lattice parameters (a); relationship c/a (b) of undoped zirconium hydride **3**



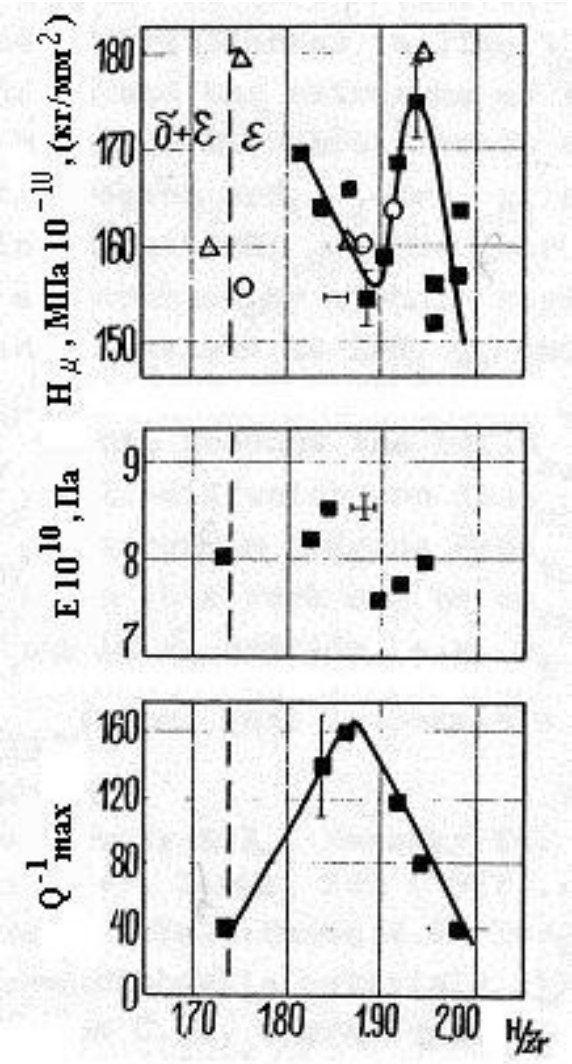
Data from:
- [Syasin V. A. 1992],
- [--],
- [W. Mueller, 1968],
-[W. L. Korst, 1962],
-[R. Beck, 1962],
-[K. G. Barraclough,1970].

Structure of undoped zirconium hydride $ZrH_{1.94}$ after fabrication (a) x 100 and storage during 10 years (b) × 100; (c) × 1300 **4**



Relationship between microhardness (H_μ), elasticity modulus (E) and internal friction ($Q^{-1}max$) of zirconium hydride composition **5a**

o - [K. G. Barraclough, 1970], Δ - [Andrievsky R. A, 1967]



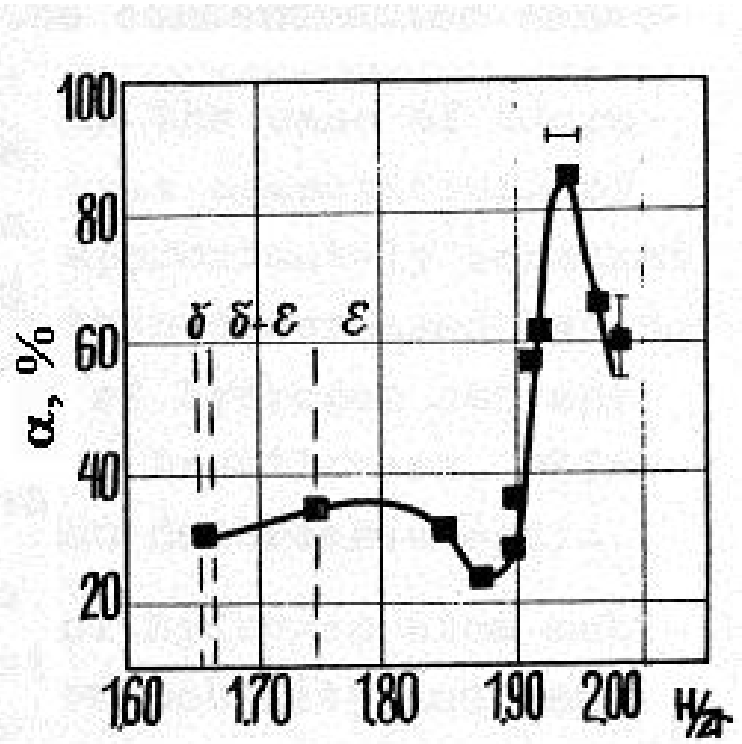
Zirconium hydride microbrittleness **5b**

$\alpha = (N_c / N) \times 100\%$

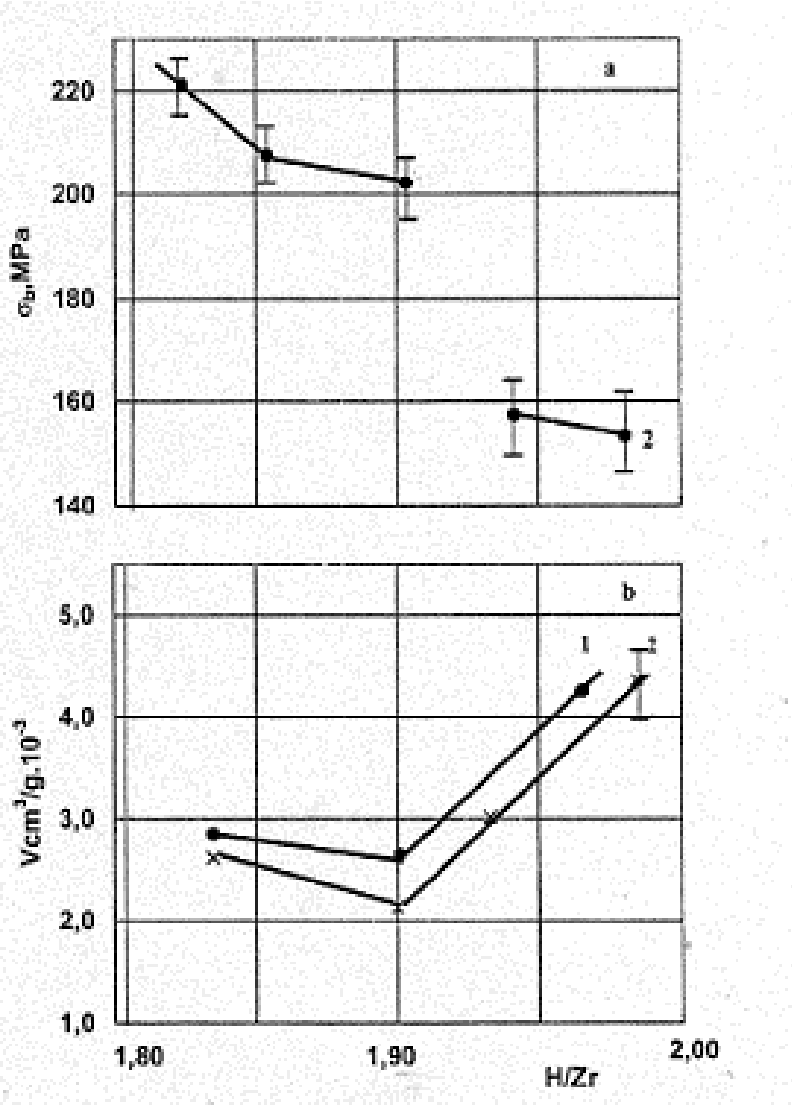
N – total number of identor traces,

N_c – number of traces with cracks

Vickers diamond identor

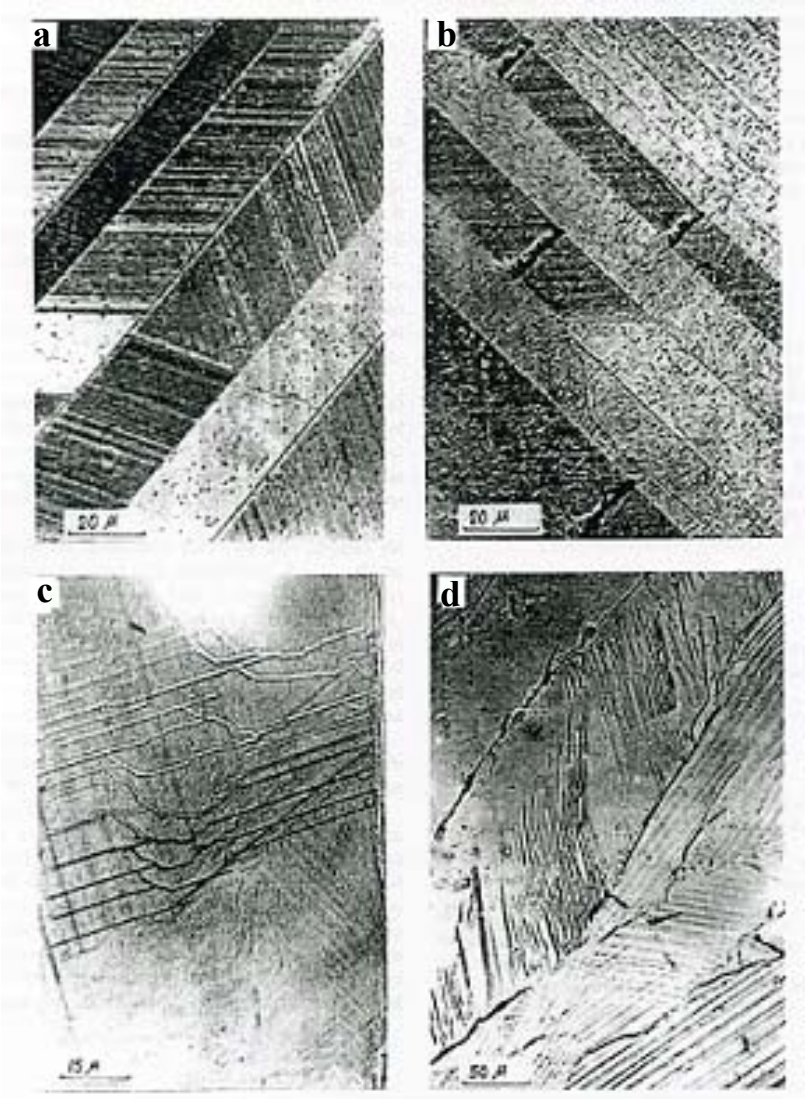


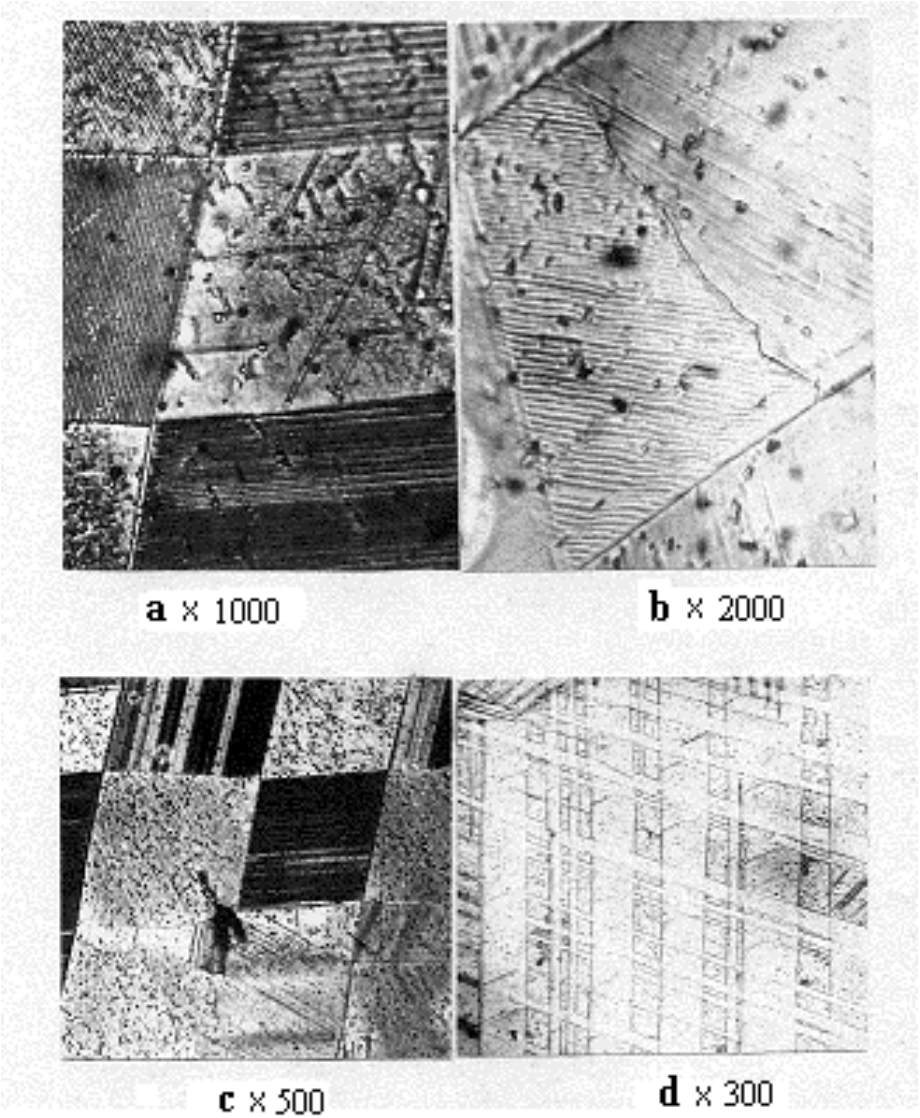
Changes in bending strength (σ_b) (a) and porosity (V) (b) ε-ZrH in relation to hydrogen content **6**



Grain size, μm
1 – (3000 – 5000),
2 – (40 – 80).

Structure changes and defect presence in zirconium ε-hydride depending on hydrogen content: (a) –twin structure $ZrH_{1.90} \times 800$, (b) –reorientation and microcracks in the twins $ZrH_{1.95} \times 800$, (c) – filling of channels - pores $ZrH_{1.95} \times 1000$, (d) – groups of channels – cavities in grains $ZrH_{1.98} \times 300$ **7**





(a) –regions of twin intersection
(b) –reorientation and development of cracks

(c) – cracks in the region of twin collision
(d) – multiple cracks in the region of twin intersection

Conclusions 9

1. Changes in density, cell unit parameters, hardness, brittleness, elasticity modulus of ε-zirconium hydride in the homogeneity region occur non-monotonically.
2. The extremums of concentration dependences for these characteristics correspond to $ZrH_{1.90}$ and $ZrH_{1.94}$ compositions.
3. For more than $ZrH_{1.90}$ compositions a sharp increase in the number of pores and microcracks is observed that causes a significant reduction of ε-zirconium hydride strength.
4. Presence of defects in ε-zirconium hydride in the form of pores, microcracks, channels is associated with peculiarities of formation of the twin structure and its further variation resulted from hydrogen saturation.

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