SFR-2016

Structural phase transformations study of brittle refractory metals and intermetallics with $L1_2$ structure using synchrotron radiation

PILYUGIN, Vitaliy
SOLOV'EVA, Yulia
ANCHAROV, Alexey
STARENCHENKO, Vladimir
STARENCHENKO, Svetlana
TOLMACHEV, Timofey
M.N. Mikheev Institute of Metal Physics of the Ural Branch of the Russian Academy of Sciences (IMP UB RAS)
Tomsk State University of Architecture and Building
Institute of Solid State Chemistry and Mechanochemistry SB RAS

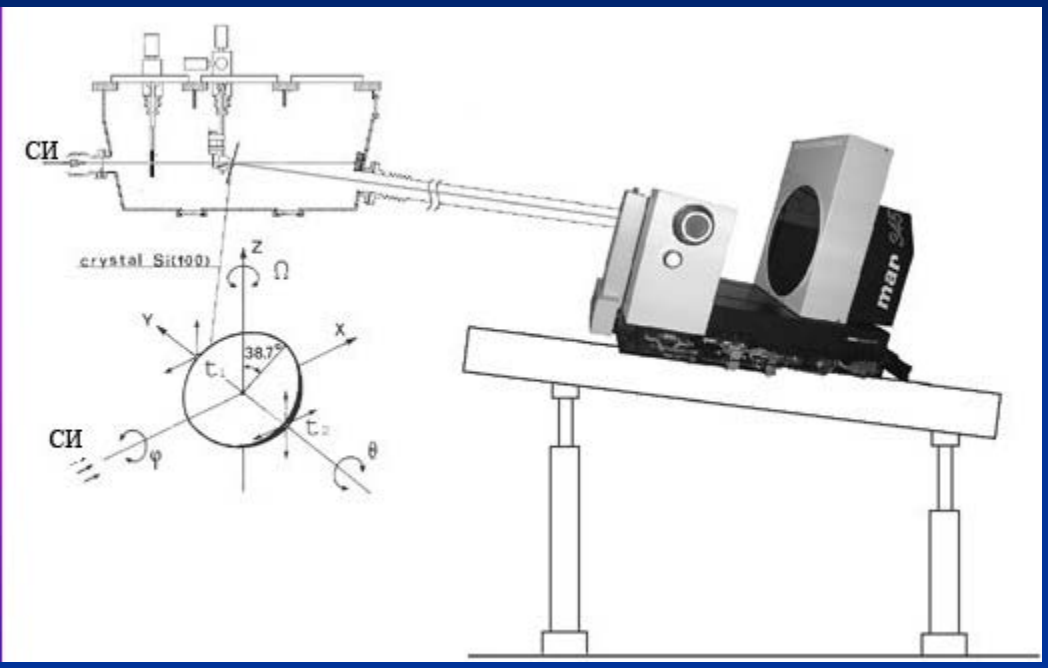
Aims, materials and methods

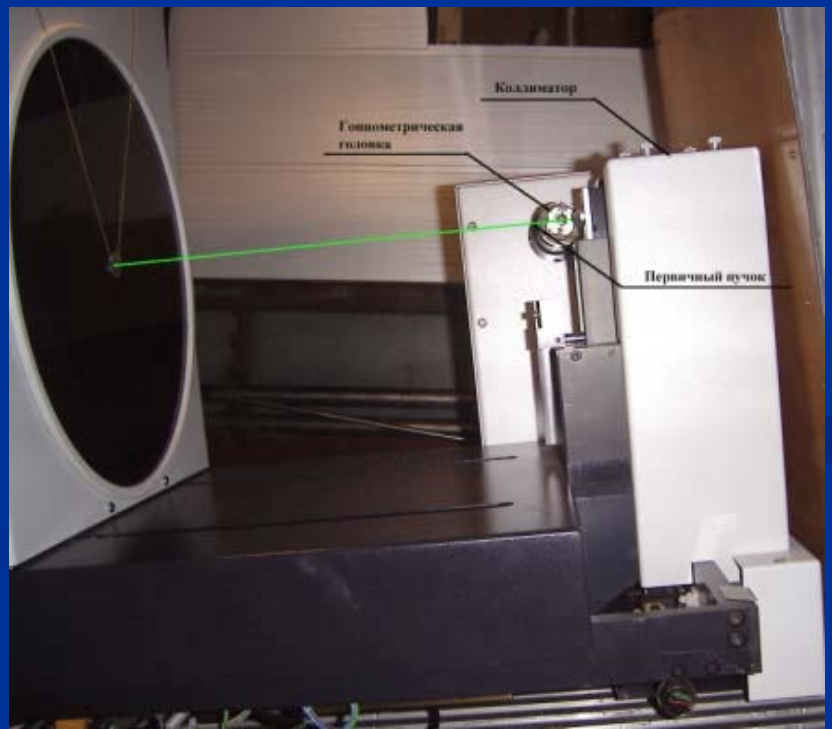
Study of microstructure and phase state: intermetallic Ni_3Ge, with anomalous properties, transitional 3d-4d metals (Fe, Ti, Zr), including refractory fragile (Mo, Ir, Re) after deformation under high pressure (HPT)

SR, NGR, TEM, SEM, metalography, mechanical tests

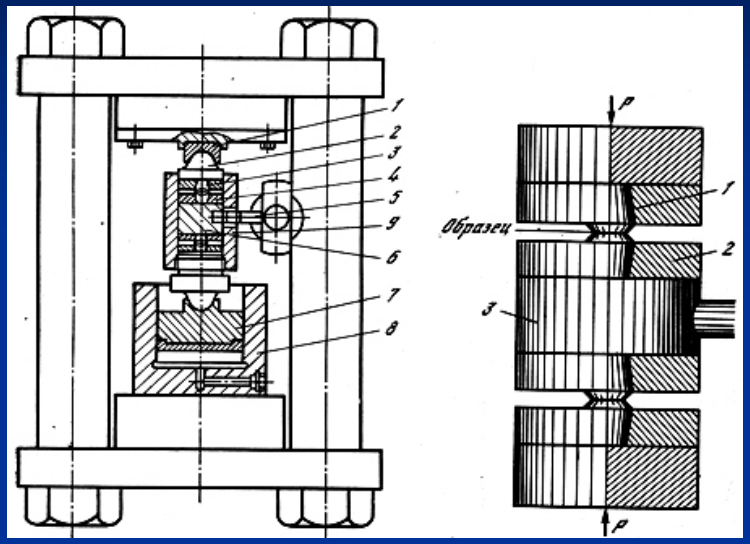
SCSTR Budker INP SB RAS

Diffractometry in hard X-rays λ=0.3686 A°

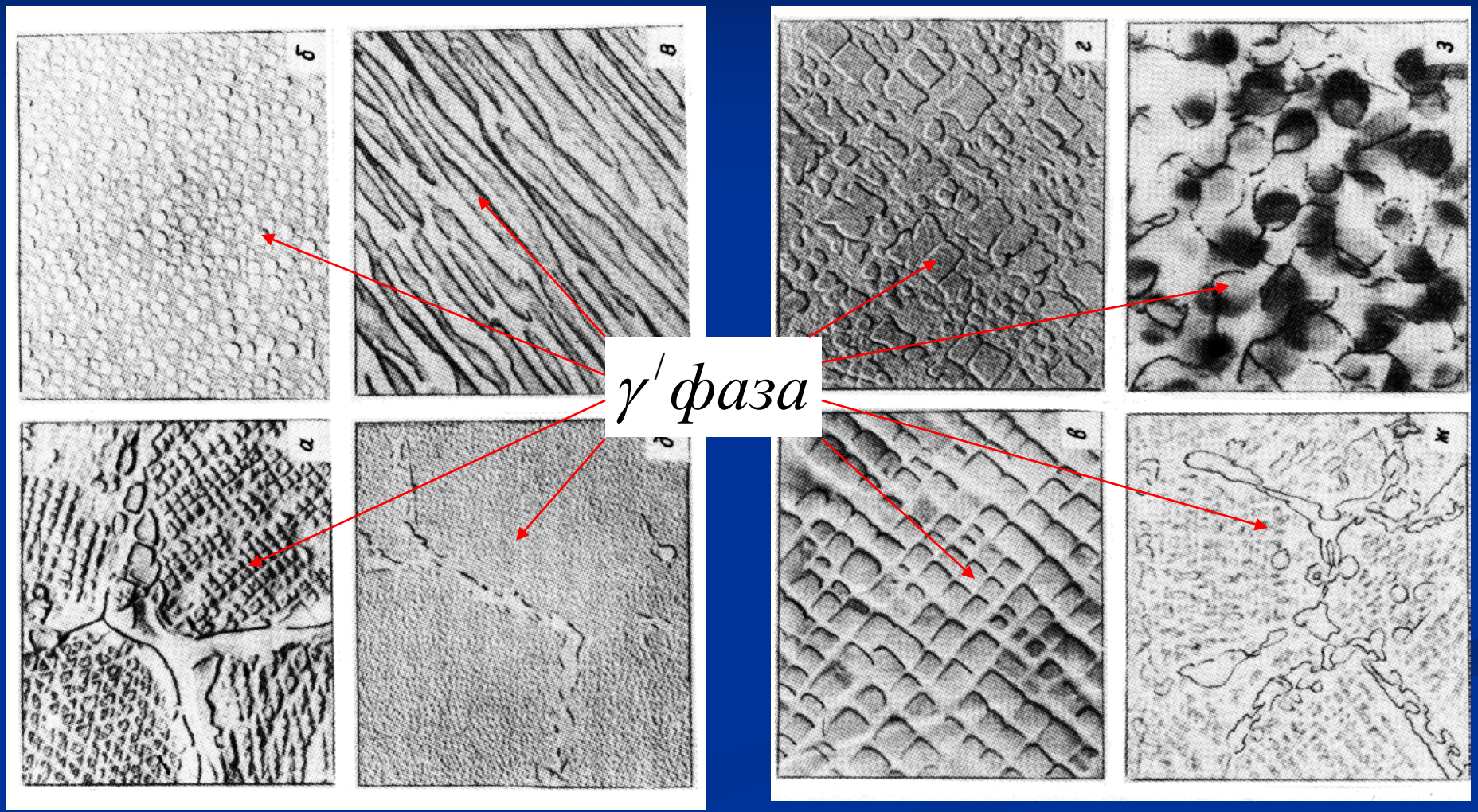




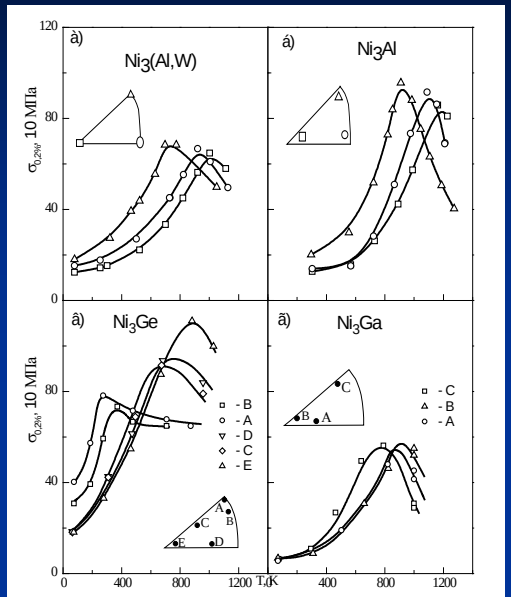
HPT in Bridgman anvils - shear under pressure. Ag in situ under pressure 12 GPa between c-NB,
SR, λ=0.3686 A°

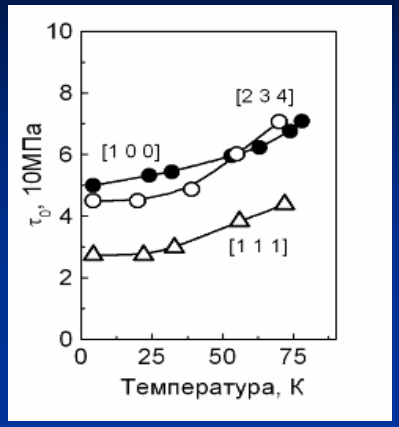


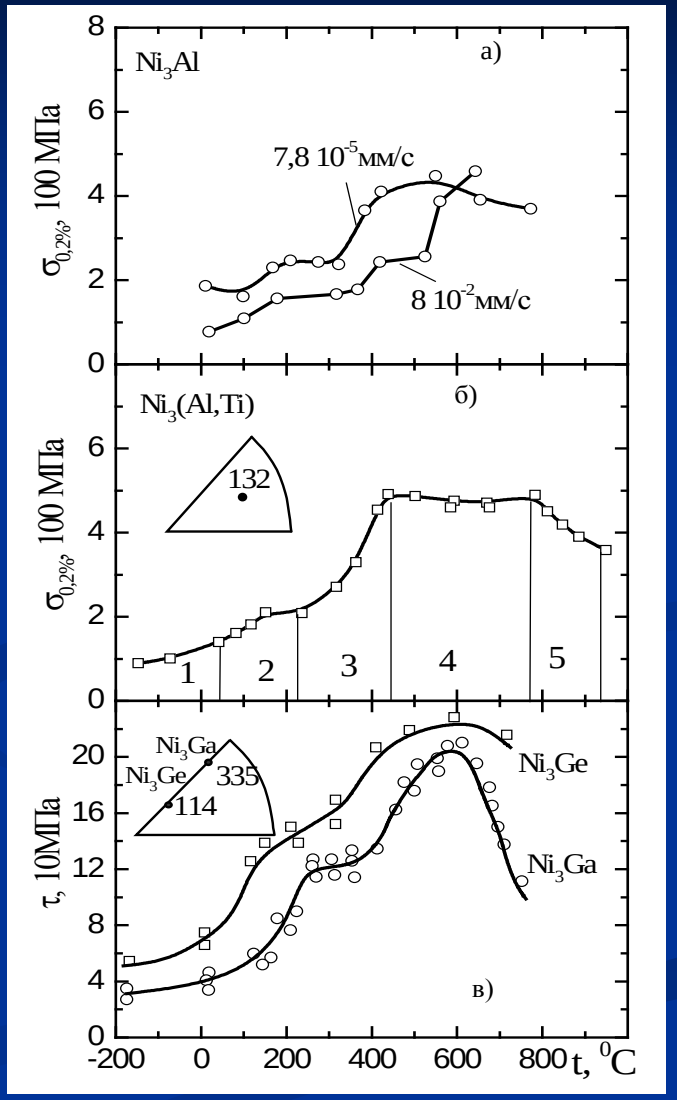
The microstructure of superalloys with intermetallic phase (Ni_3Ge, Ni_3Al, Ni_3Fe)

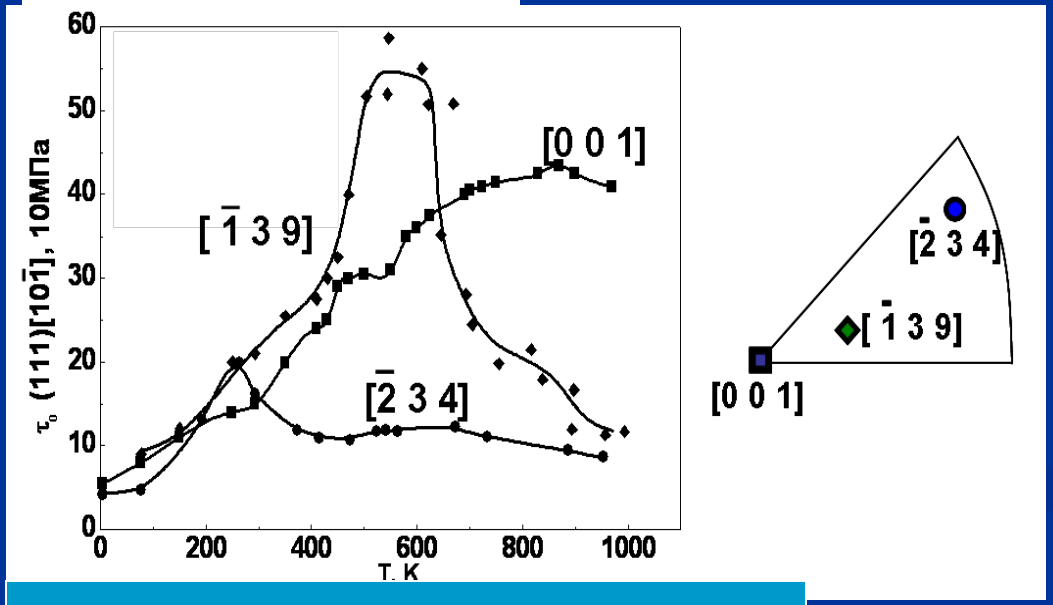


Alloys with anomalous temperature dependence of the flow stresses: Ni_3Ge, Ni_3Al, Ni_3Fe, Ni_3W





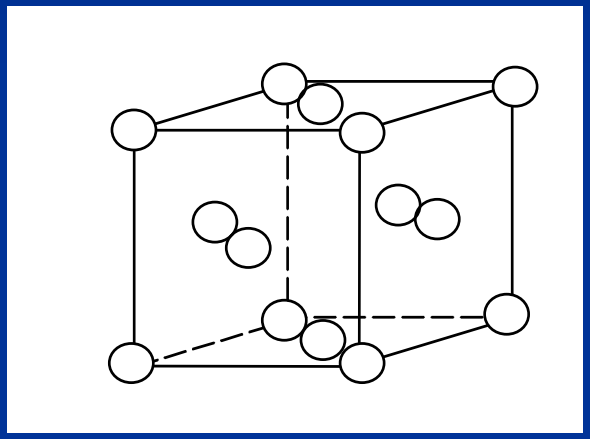




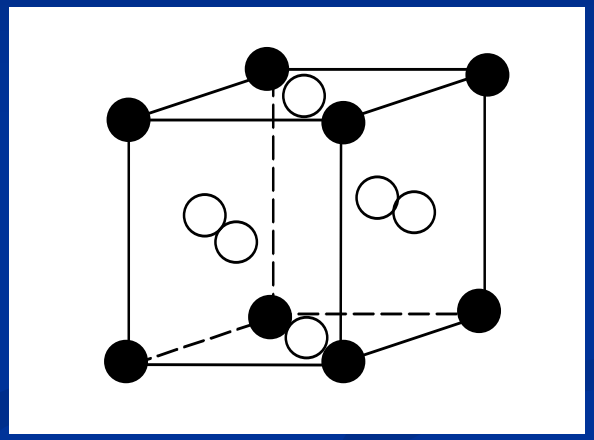
The data of different authors

SFR-2016

Superstructure $L1_2$



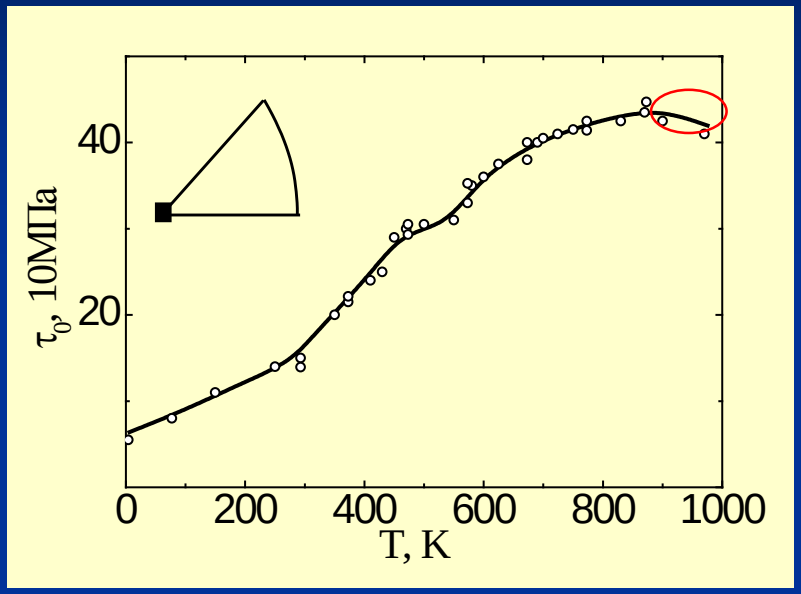
FCC - lattice

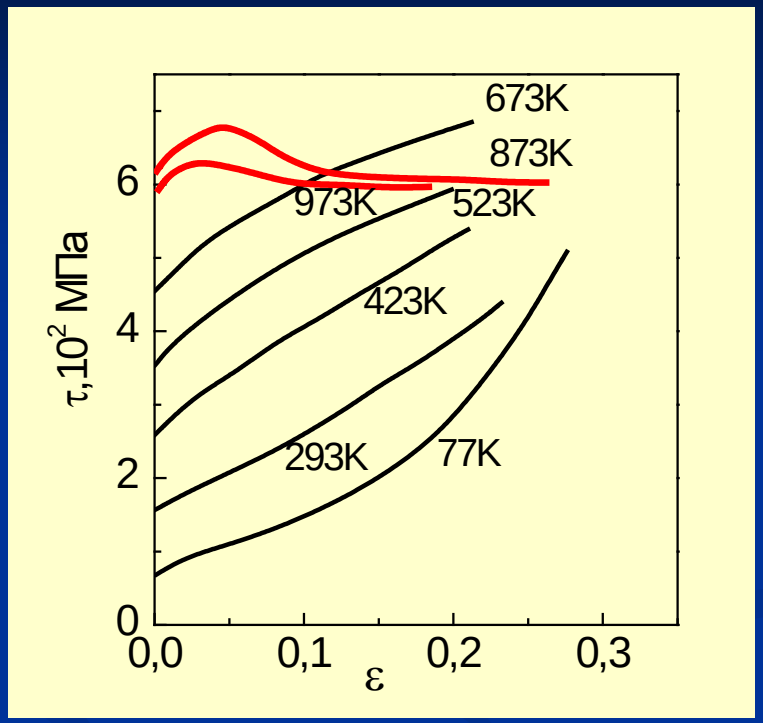


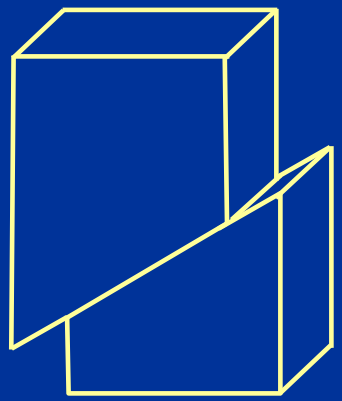
● – **A atoms**

○– **B** atoms

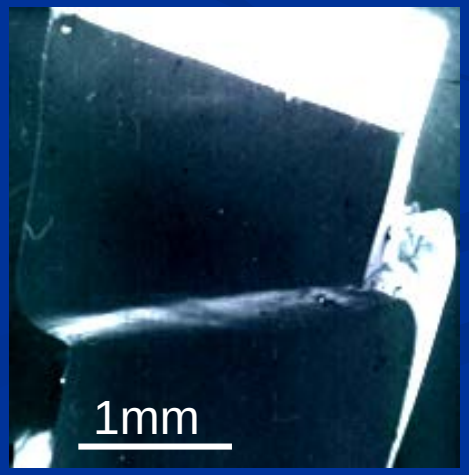
Plastic deformation superlocalization





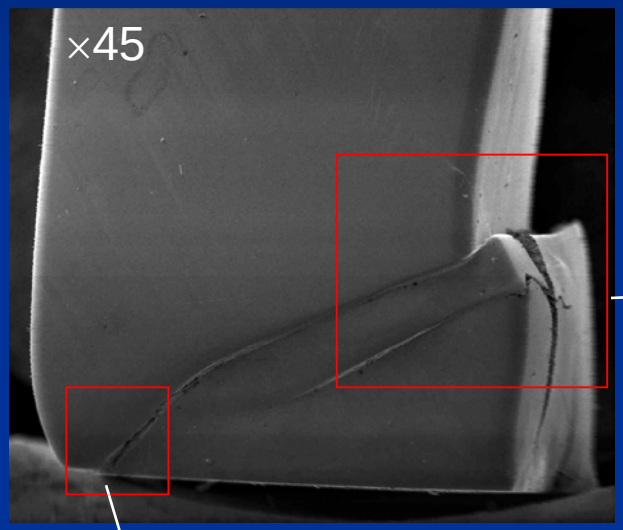


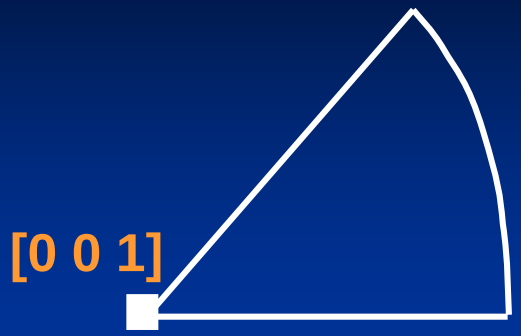
$$\frac{T}{T_{пл}} > 0{,}6$$

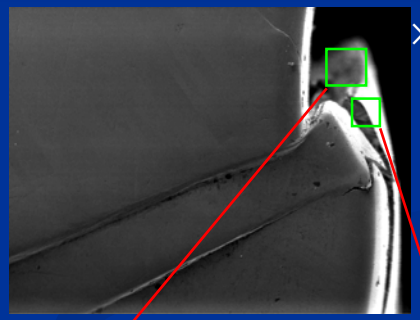


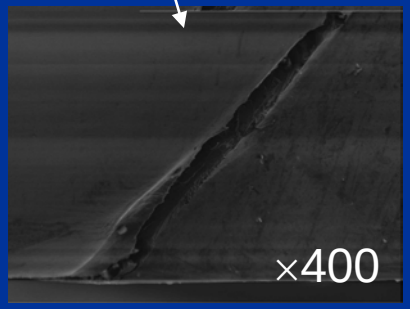
Plastic deformation superlocalization

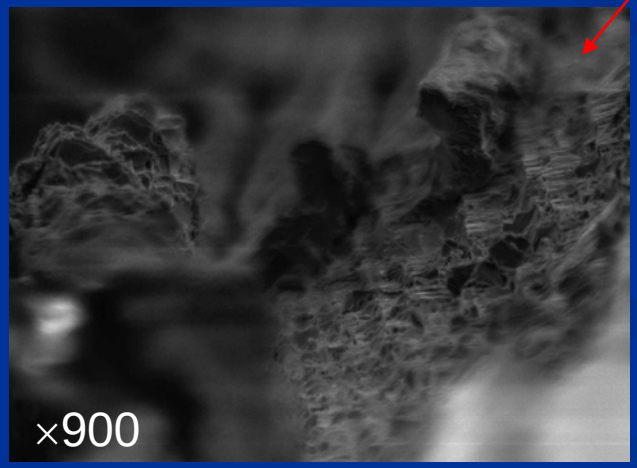
T=923K, ε≈13%

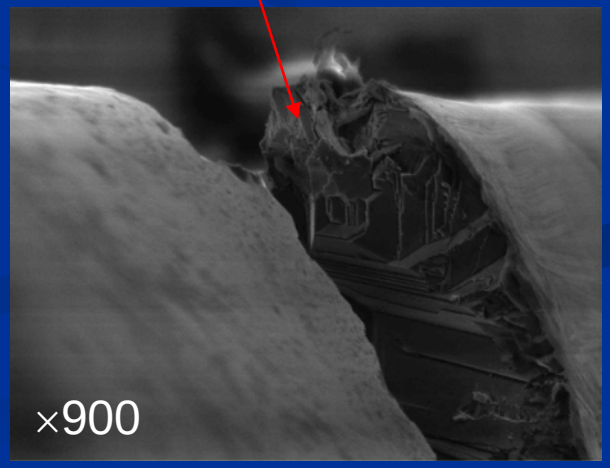


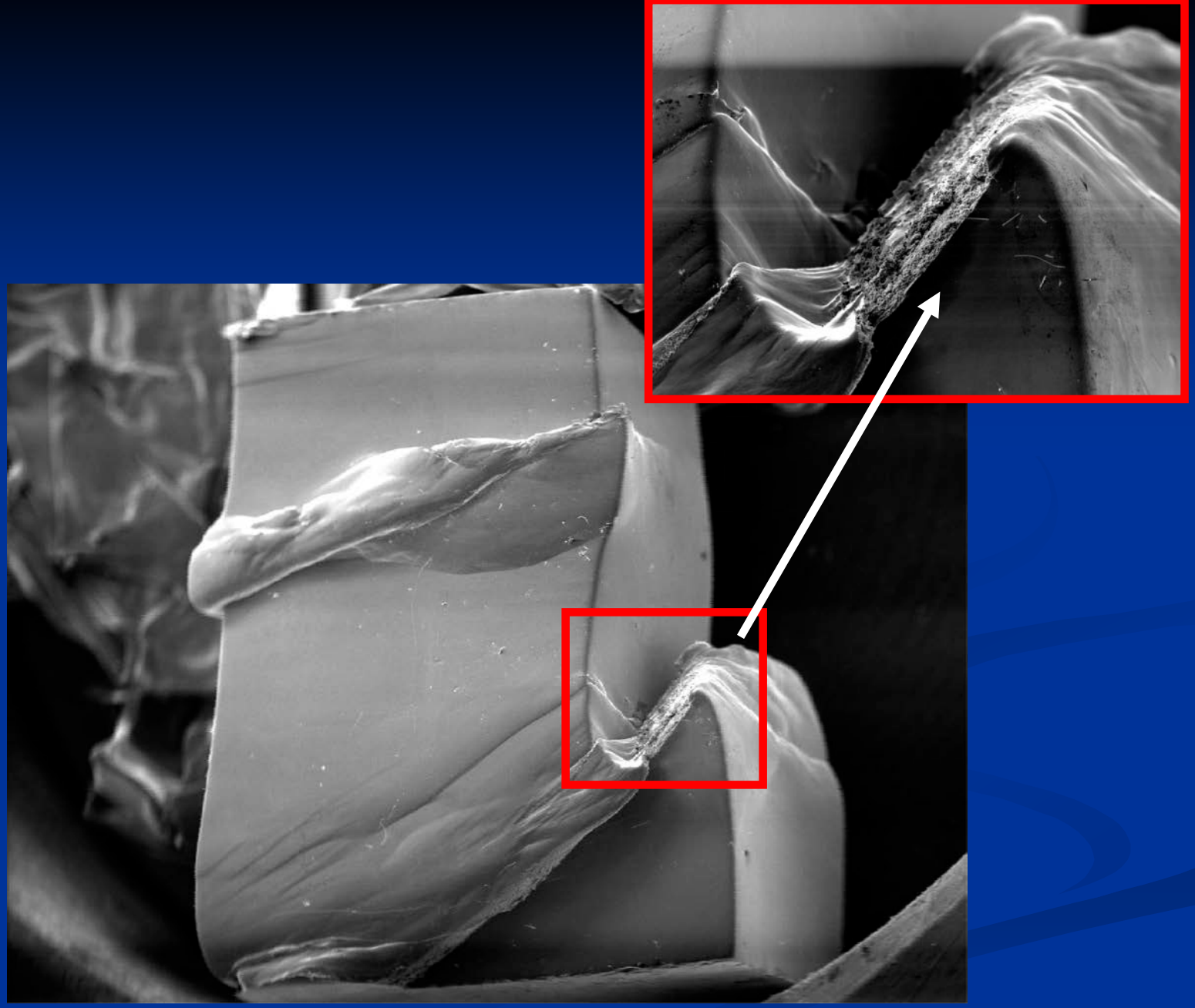






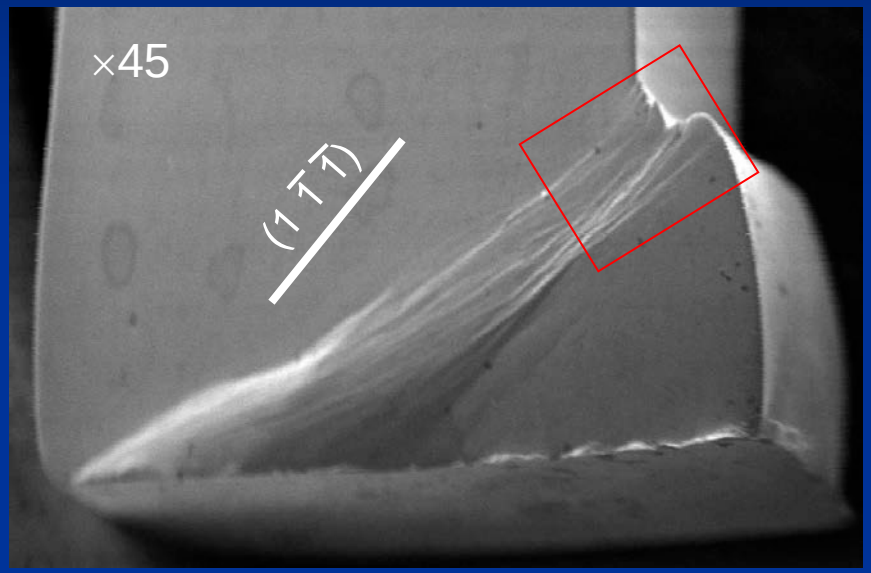


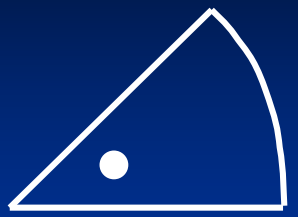


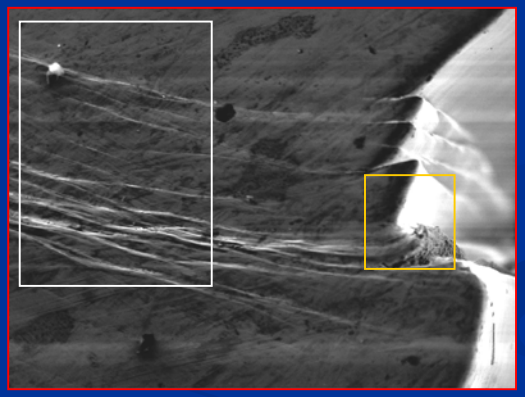


Plastic deformation superlocalization

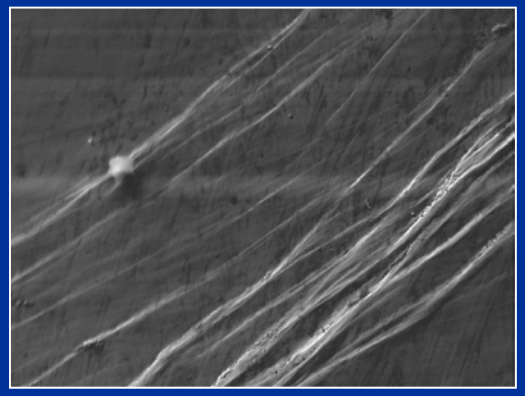
T=973K, ε≈9% (SCAN)

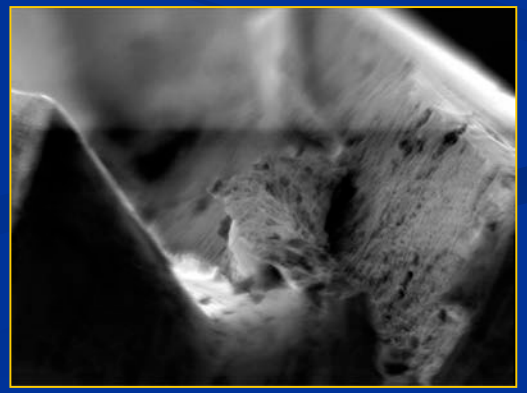


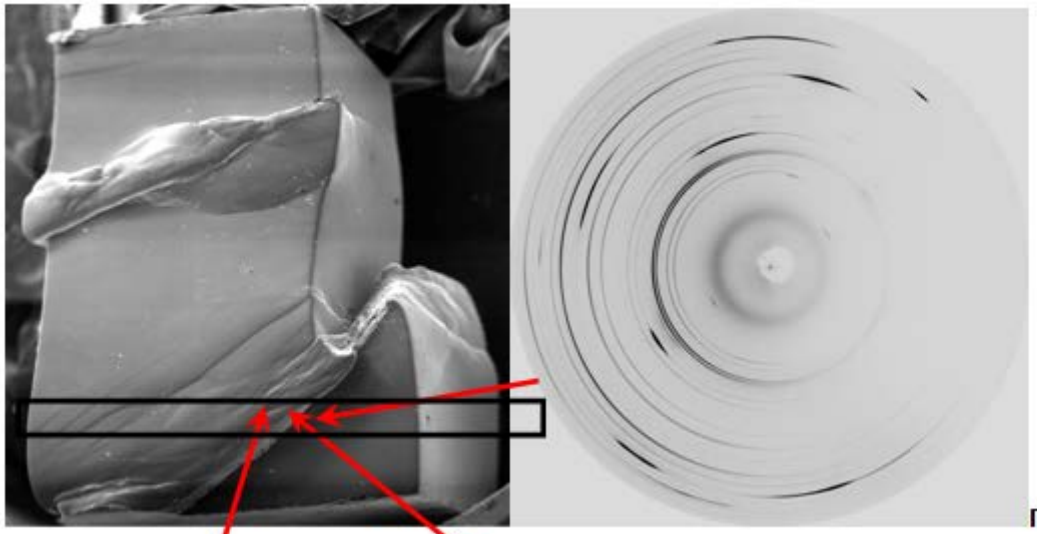


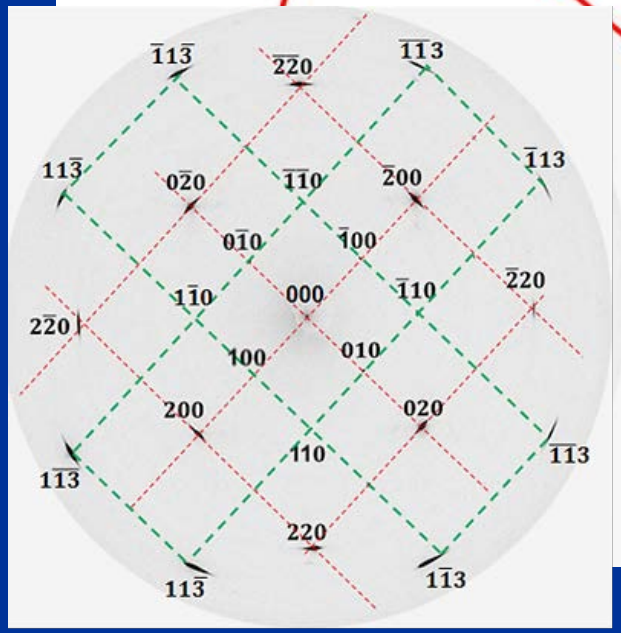


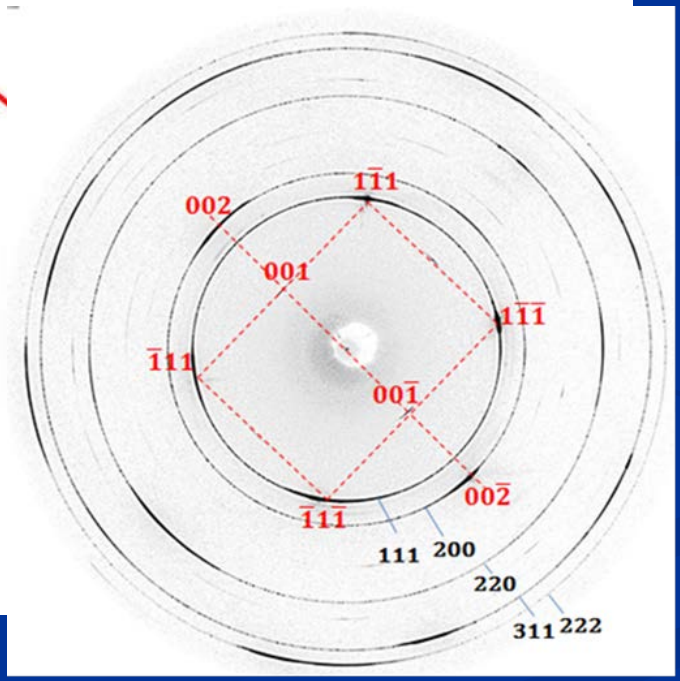
×1200









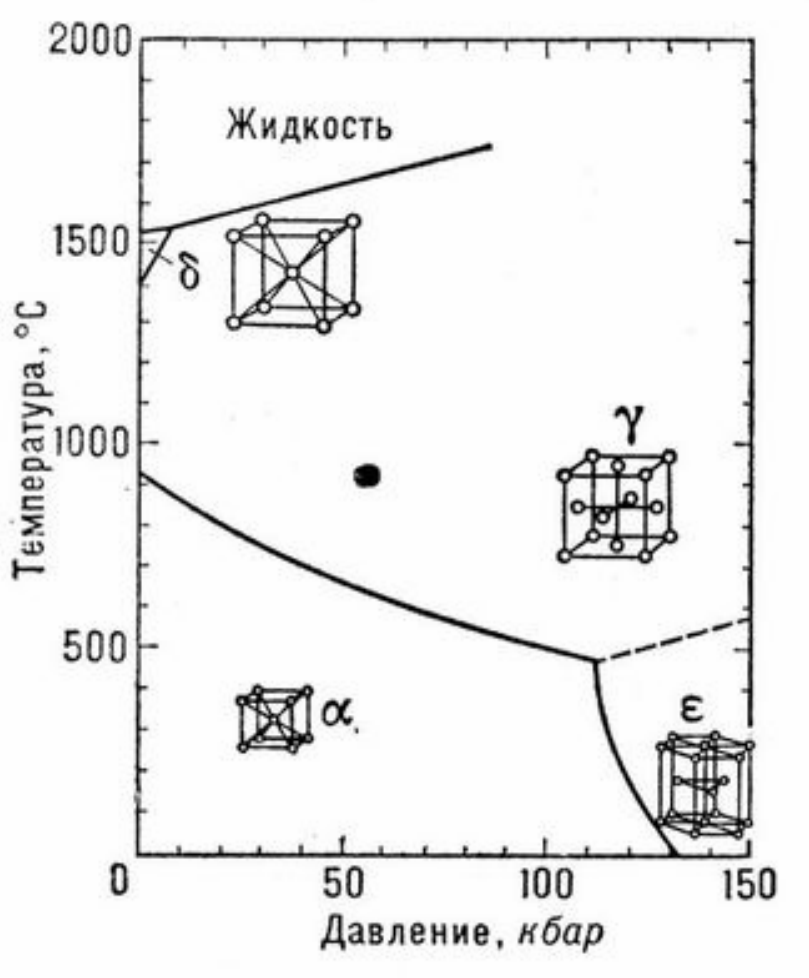


Single crystal: (001) (031) (301)

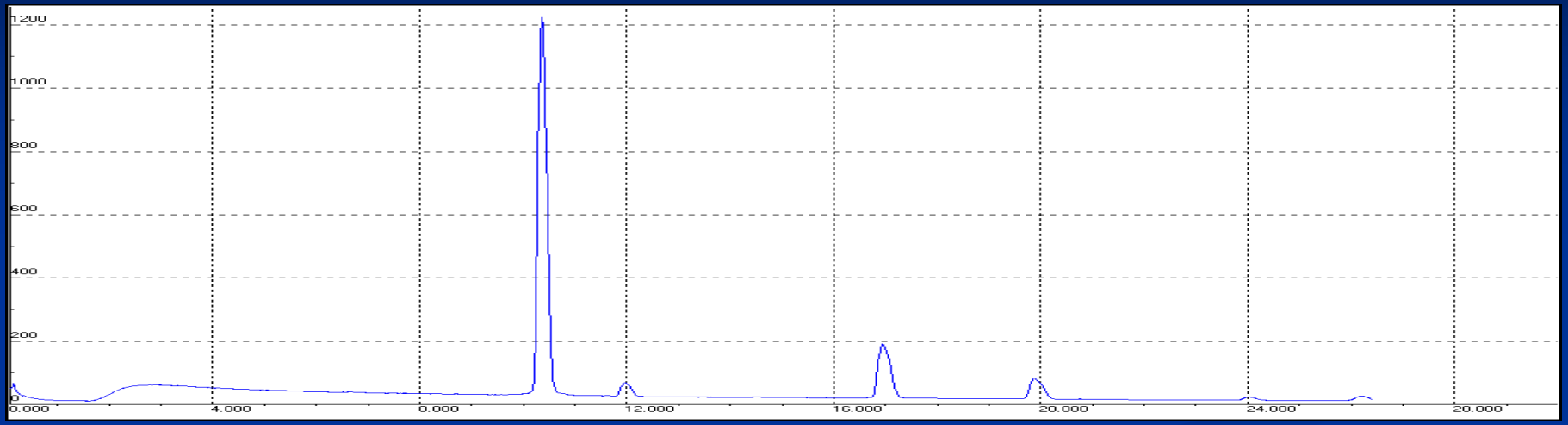
Polycrystalline

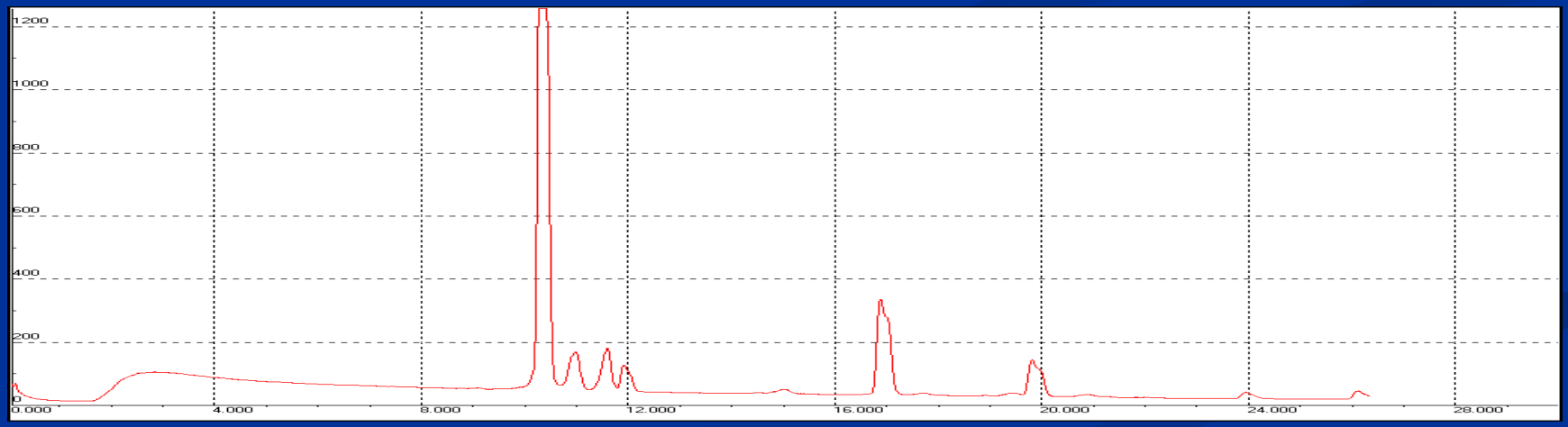
Phase transitions

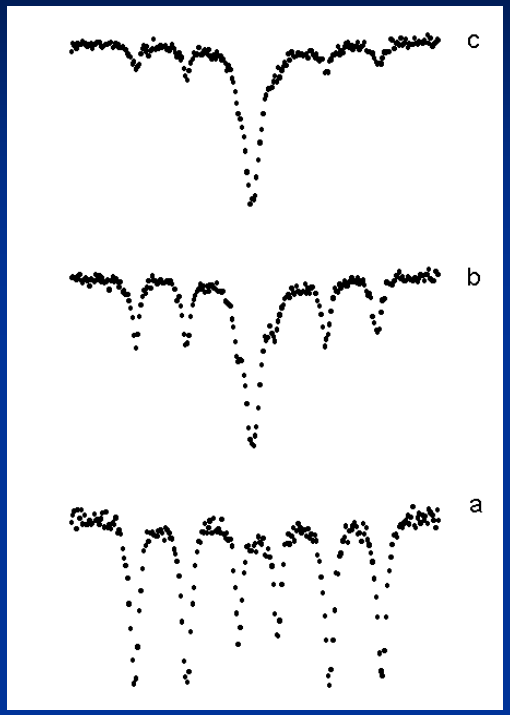
Fe phase diagram

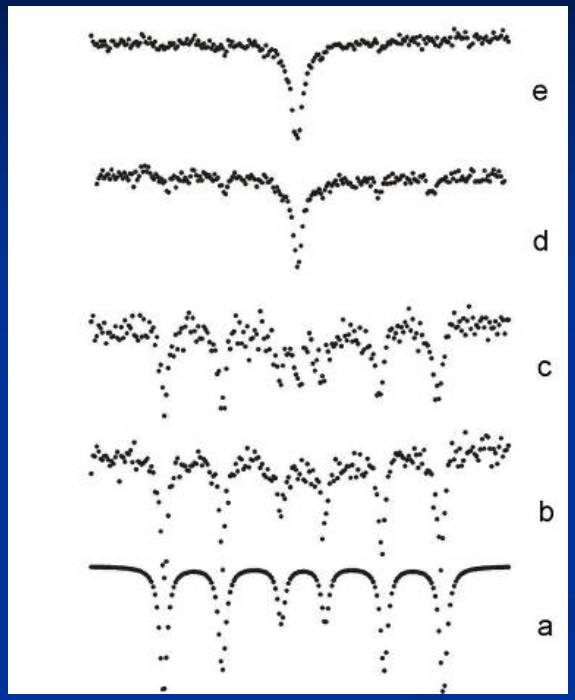


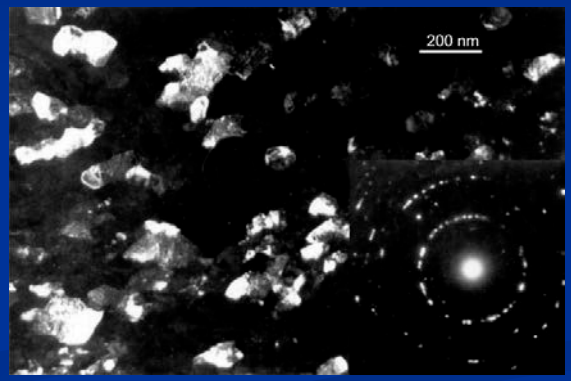
λ = 0,368 °A:
Anvils c- NB;
Fe: c-NB + ε-phase, P=14 GPa







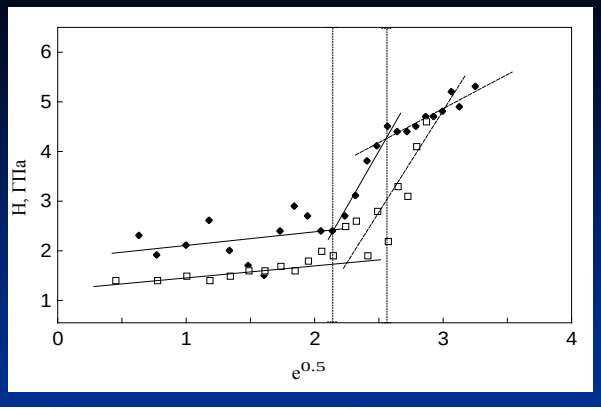




Mössbauer spectra of strained iron under pressure. Left: CG sample. a – initial state b – 14.5 GPa, 45 % hcp; c – 16 GPa, 70 % hcp. Right: NC sample. a – initial state of the sample outside of anvils; b – 8.0 GPa 0 % hcp ; c – 16.8 GPa 11 % hcp; d – 18.5 GPa 48 % hcp; e – 19.5 GPa 72 % hcp

HYSTERESIS OF α-ε TRANSITION IN IRON

In situ data NGR and SR



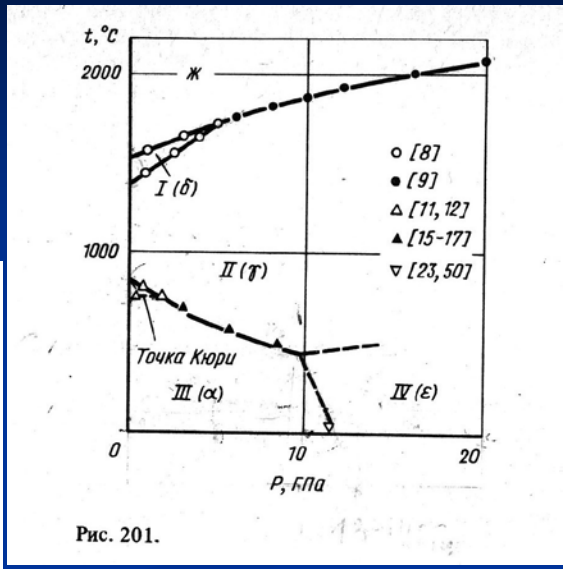
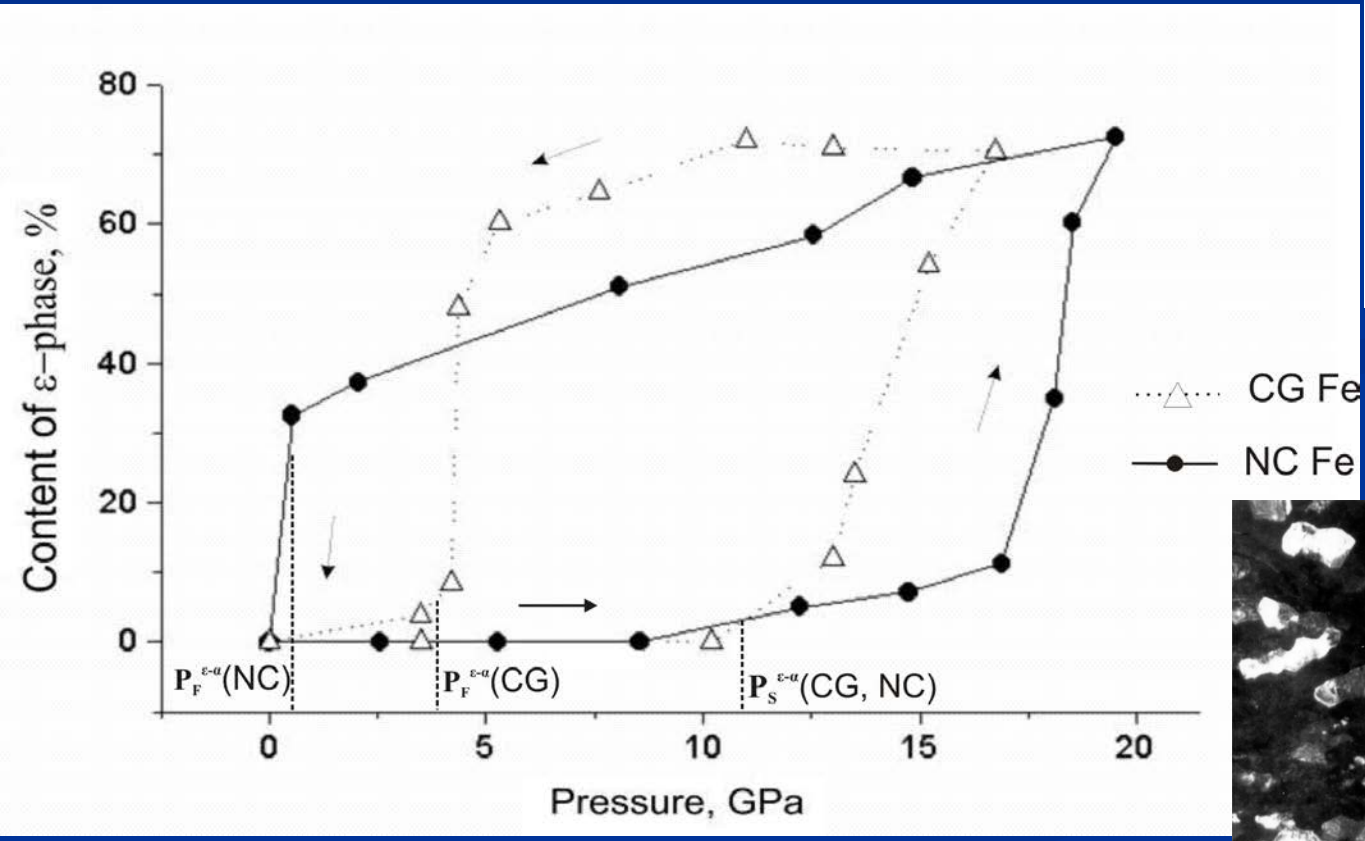
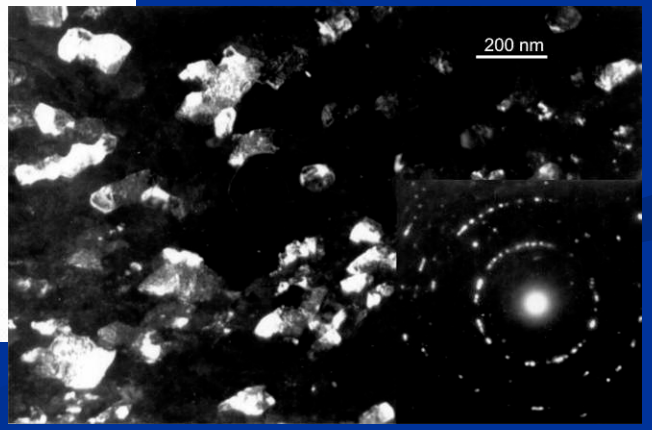


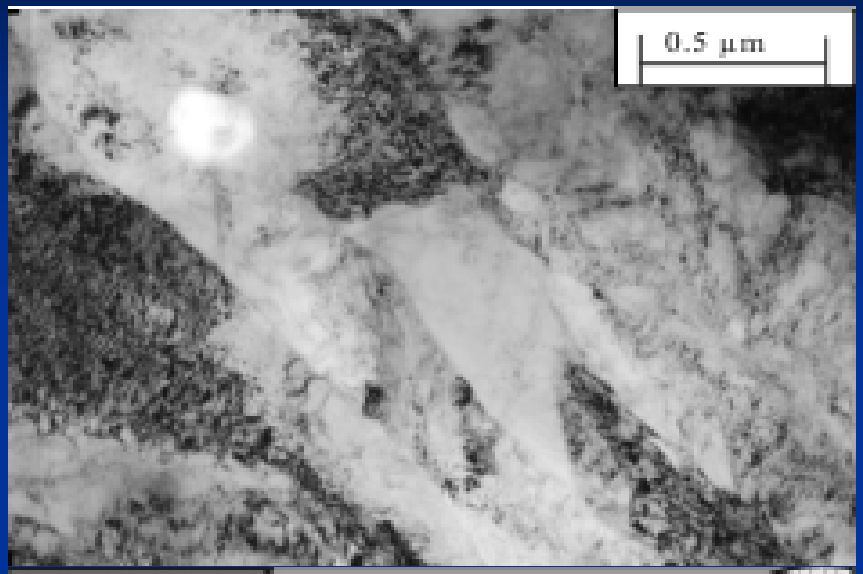
Рис. 201.

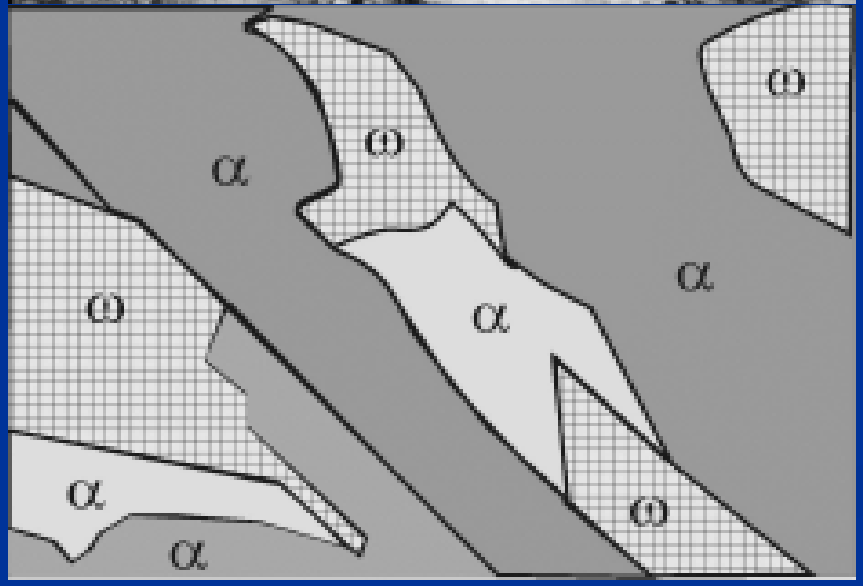


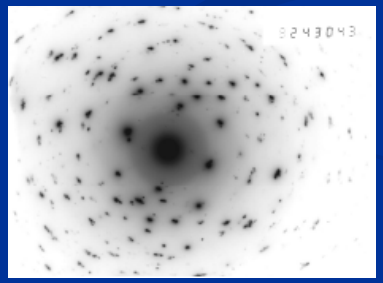
ΔH = 4 ГПа

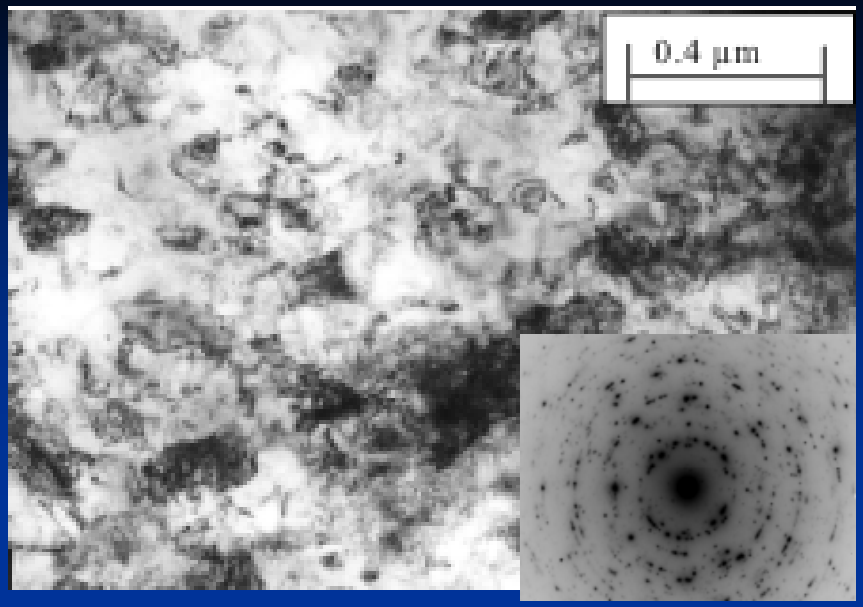


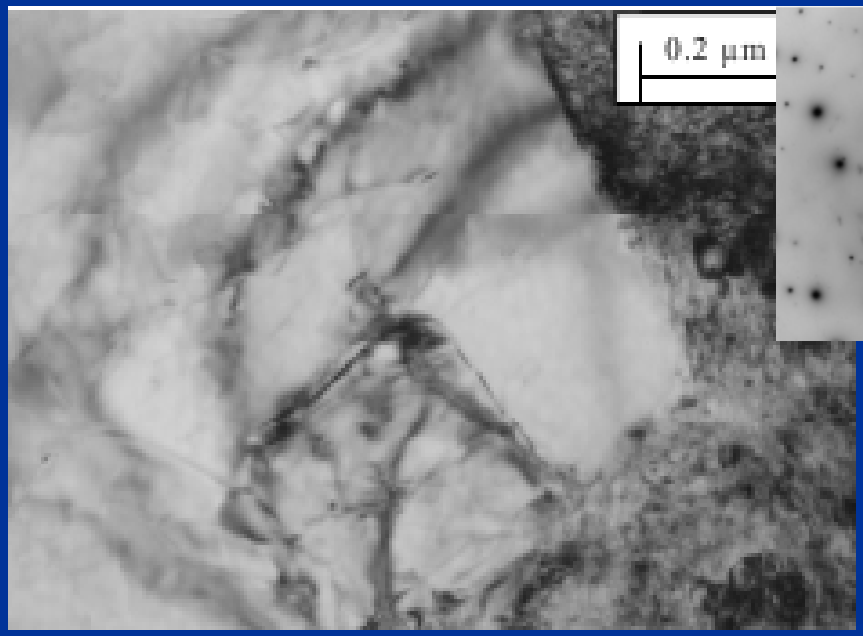
Ti

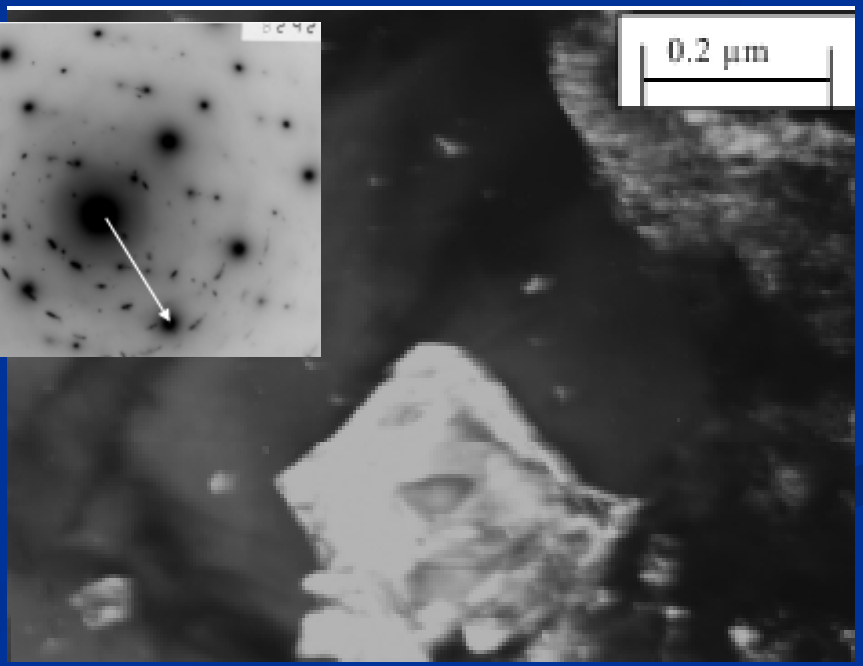




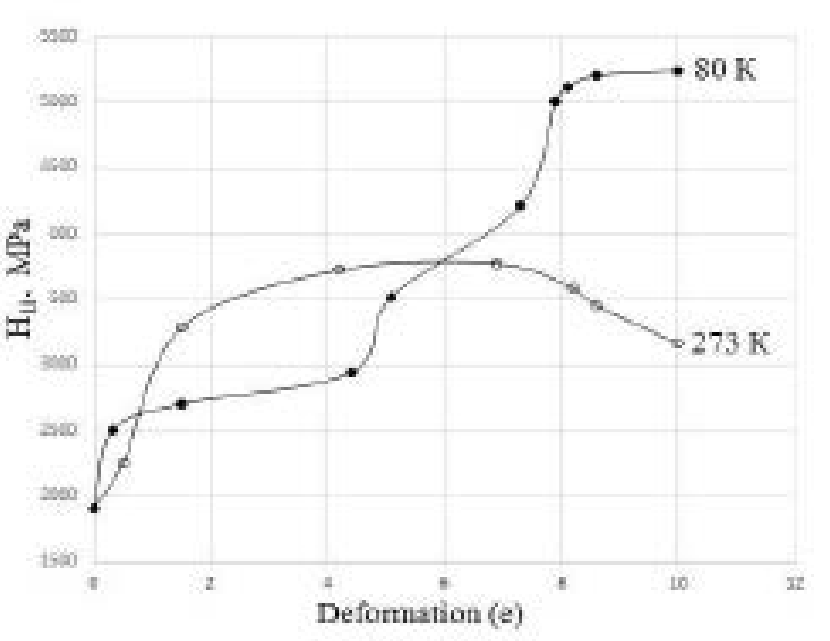


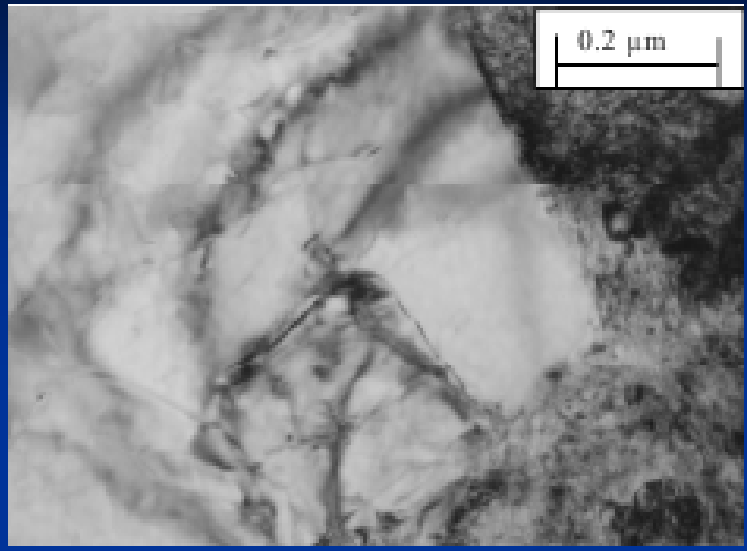

0.4 μm

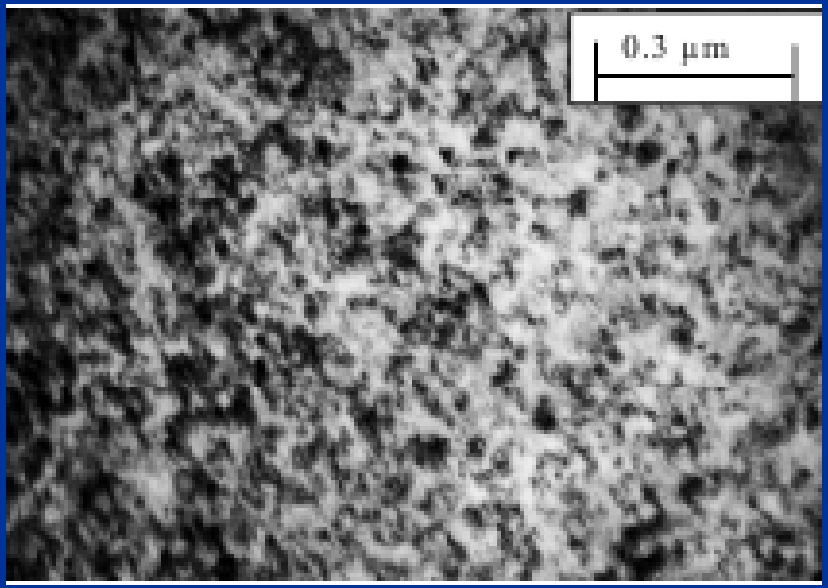

0.2 μm

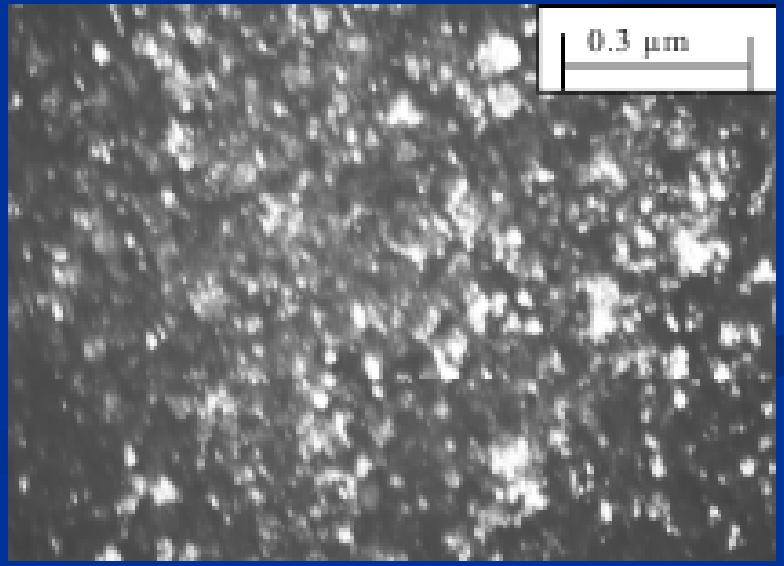

0.2 μm

Ti







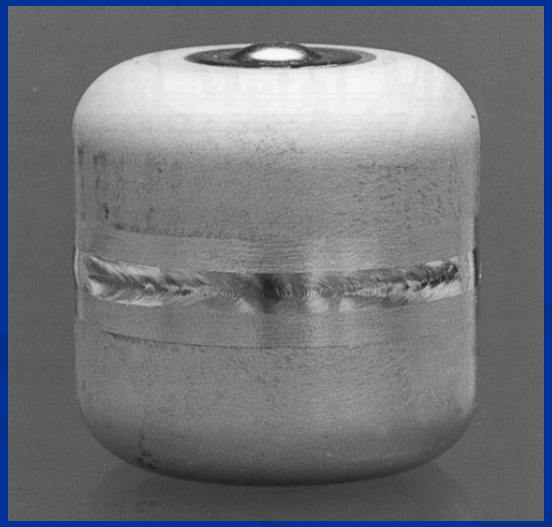


The mechanical properties of refractory 4d-metals

	B, GPa	G, GPa	μ	σ_B, MPa	δ,%	Ψ,%	H_μ,GPa
W	350-400	125-155	0.3	1000	0.6%	0%	3.480-3.800
Ir	520-590	199-266	0.28	490	6-10% (70% м/к)	10-15%	1.960-2.350
Ta	190	70	0.35	204	30%	75%	2.310

Products made of iridium

Container of plutonium oxide alloy Ir-0.3% W for thermoelectric generator, Galileo, 1989

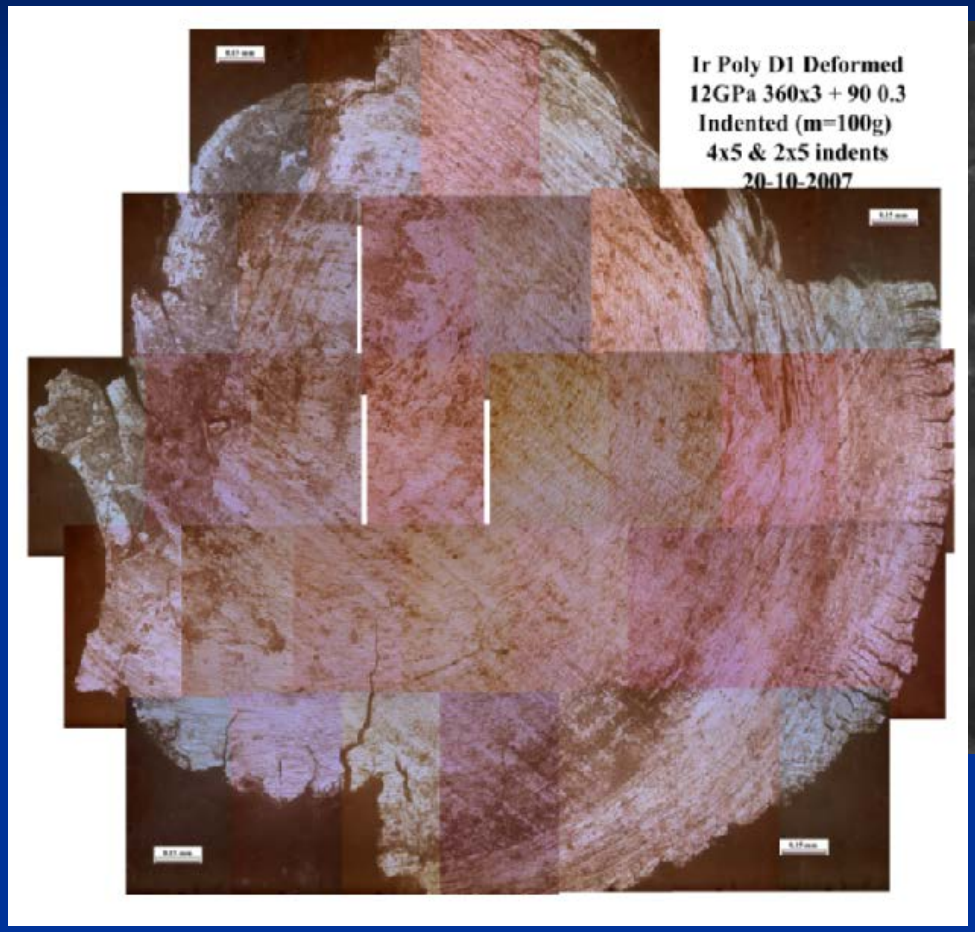


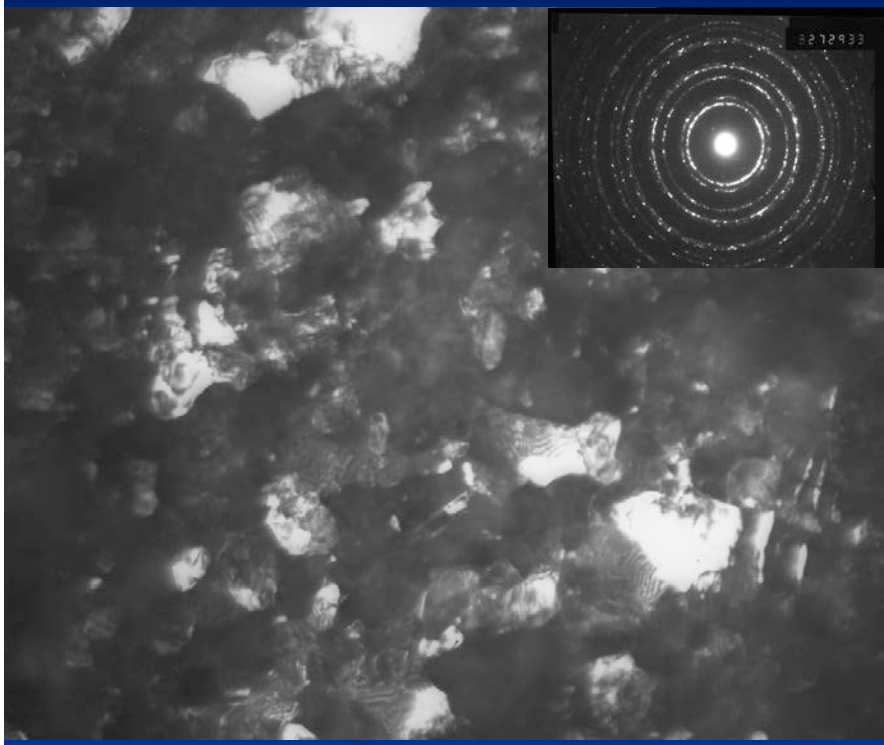
Iridium crucibles of different shapes, wire, rolled, tubes, ingotshigh-processed metal, massive single crystals (Ekaterinburg plant)

Franko-Ferreira E.A., Goodwin G.M., George T.G., Rinehart G.H. Long life radioisotopic sources encapsulated in platinum metal alloys. Platinum Metals Rev.-1997.-vol. 41, No 4, pp. 154 – 163 (Окриджская национальная лаборатория, США)


Ir Poly Discs Indented (m=100g)
Deformed
Initial
20-10-2007

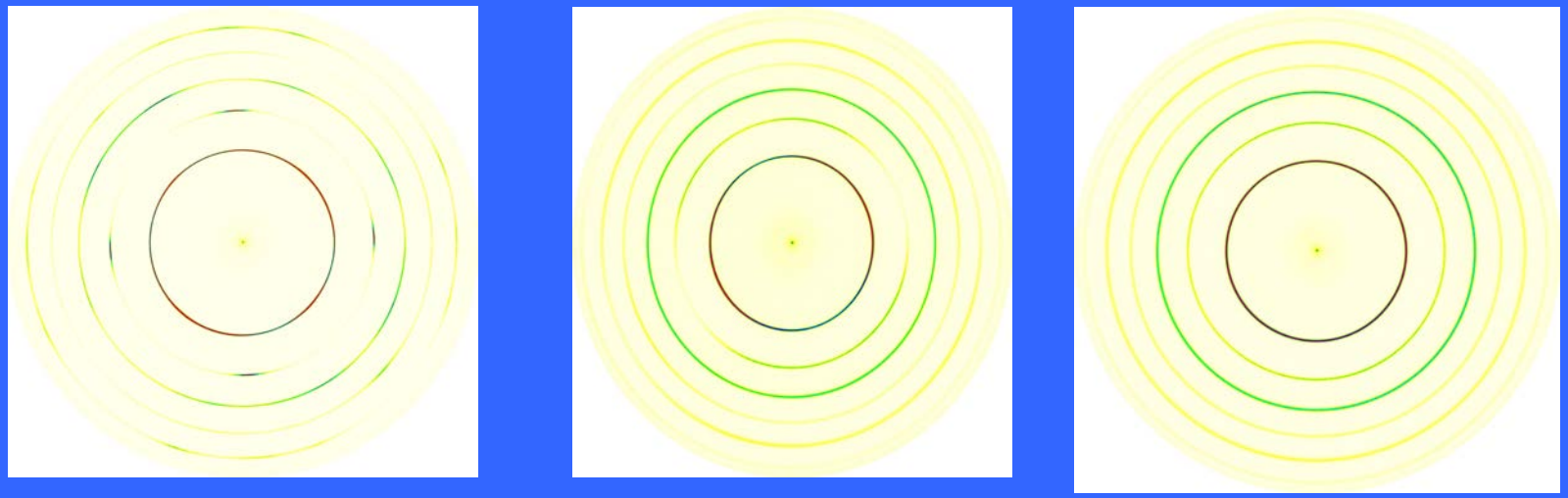
Ir, HPT ε≥5, 14 GPa





Nanostructure of iridium

Ta diffraction patterns in SR



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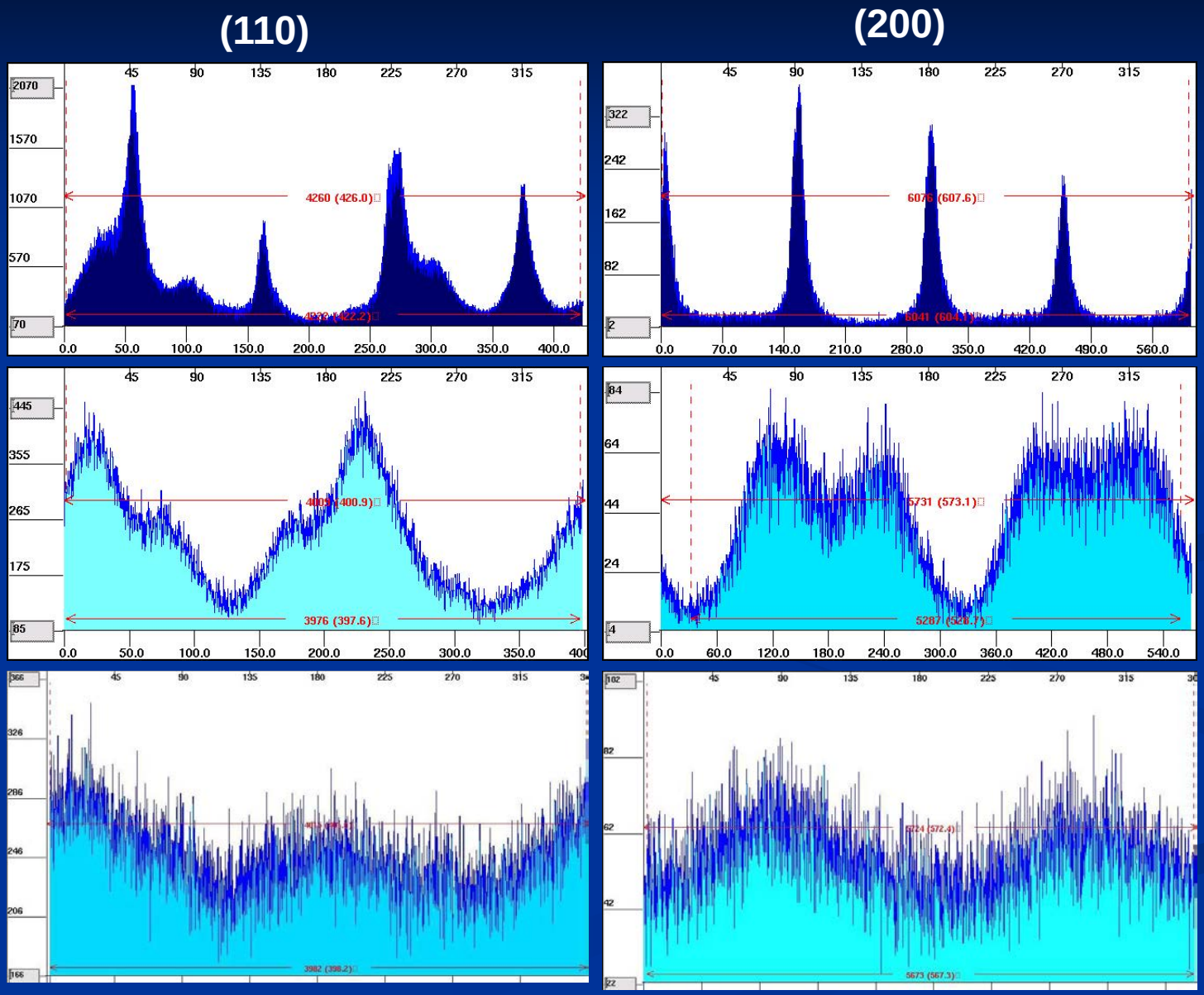
Ta texture after HPT



THANK YOU!