Comparative Study of Phase Composition in Ferritic–Martensitic Steel Surface Layers and Simulated Irradiation of 16Cr-4Al-2W-0.3Ti

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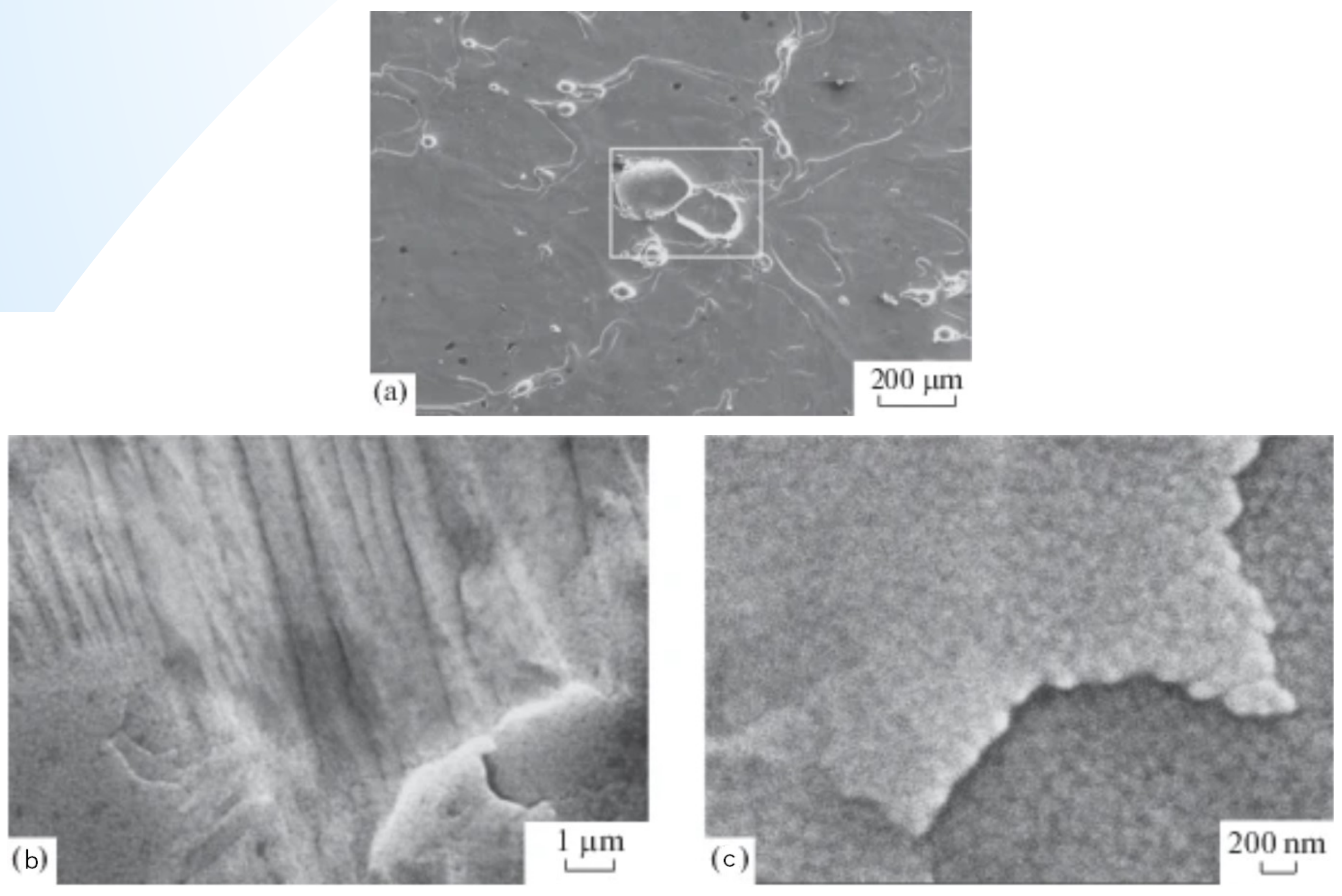
Comparative Study of Eurofer 97 and 10Cr9WV steels:

Steel sample	Regime	l, cm	N	q_{pl}	q_i
				W/cm^2	
Eurofer 97	I	18.3	7	10^7	10^9
	II	13.8	7	10^8	10^{10}
	III	4.3	12	10^{10}	10^{12}
10Cr9WV	I	18.3	5	10^7	10^9
	II	13.8	9	10^8	10^{10}
	III	4.3	6	10^{10}	10^{12}

Eurofer 97:

The Eurofer 97 steel samples in the initial state were subjected to final heat treatment (HT) under the following conditions: normalizing at 980°C, 30 min + tempering at 760°C, 90 min.



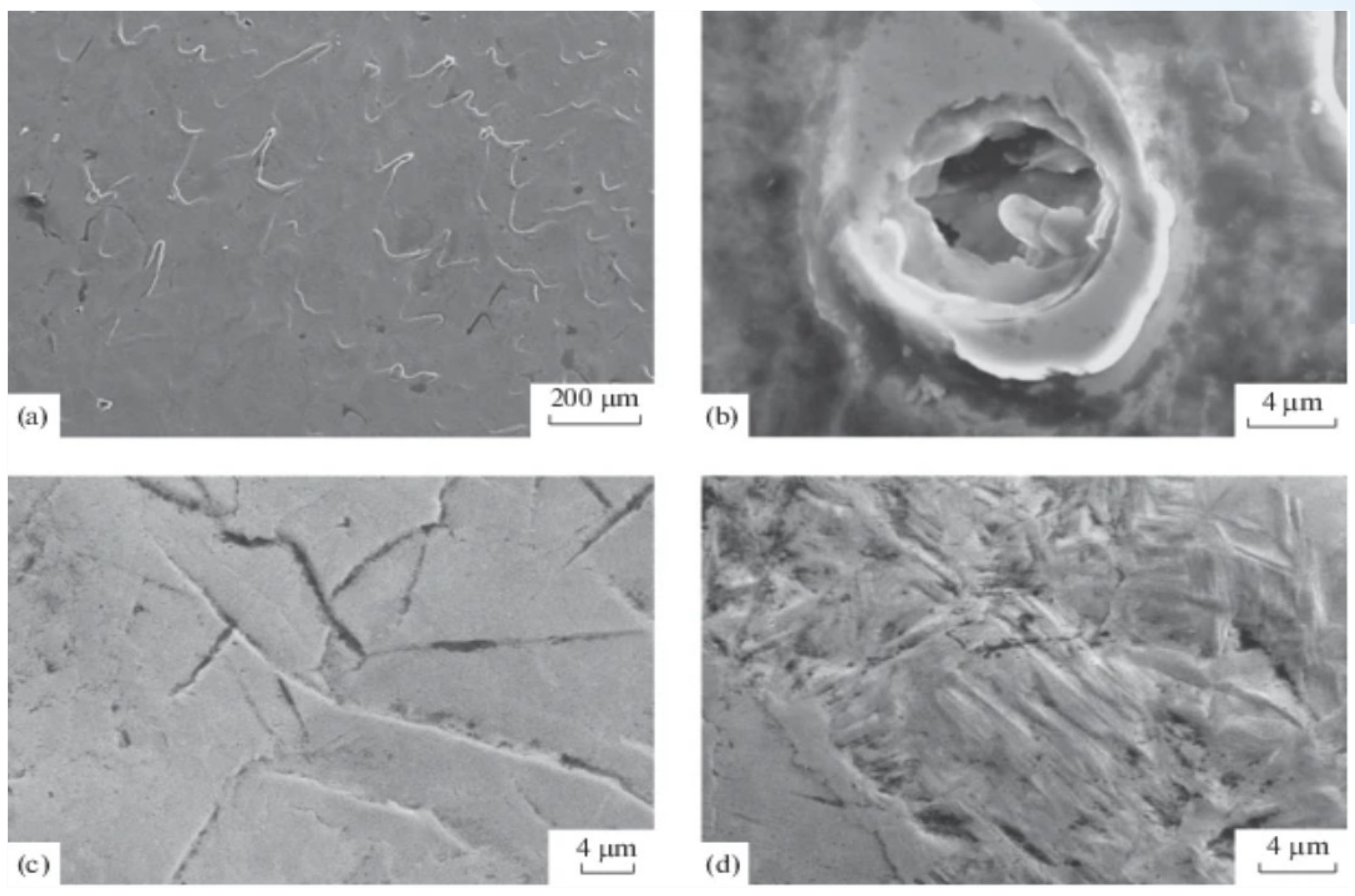
Microstructures of some surface regions ((a, b, g) general view at various magnifications) in the Eurofer 97 steel subjected to irradiation in the PF setup at a distance of 4.3 cm from its anode. Fine cellular structure of the surface layer revealed at a high magnification (c)

Regime	Eurofer 97	10Cr9WV
Initial	I	18.3
II	II	13.8
III	III	4.3

Austenite content, wt. %, in the surface layers of the Eurofer 97 and 10Cr9WV steel samples subjected to treatment in the PF setup

10Cr9WV:

The samples were irradiated without removing the surface film in order to estimate the stability of the film under the plasma beam treatment conditions and how the film can protect the base metal against melting and structure–phase changes.



Surface microstructure of the 10Cr9WV steel at a distance of 4.3 cm from the anode: (a) general view of the surface, (b) crater formed during gas release, (c) region with ferritic structure, and (d) region with martensitic structure

Irradiation of 16Cr-4Al-2W-0.3Ti steel

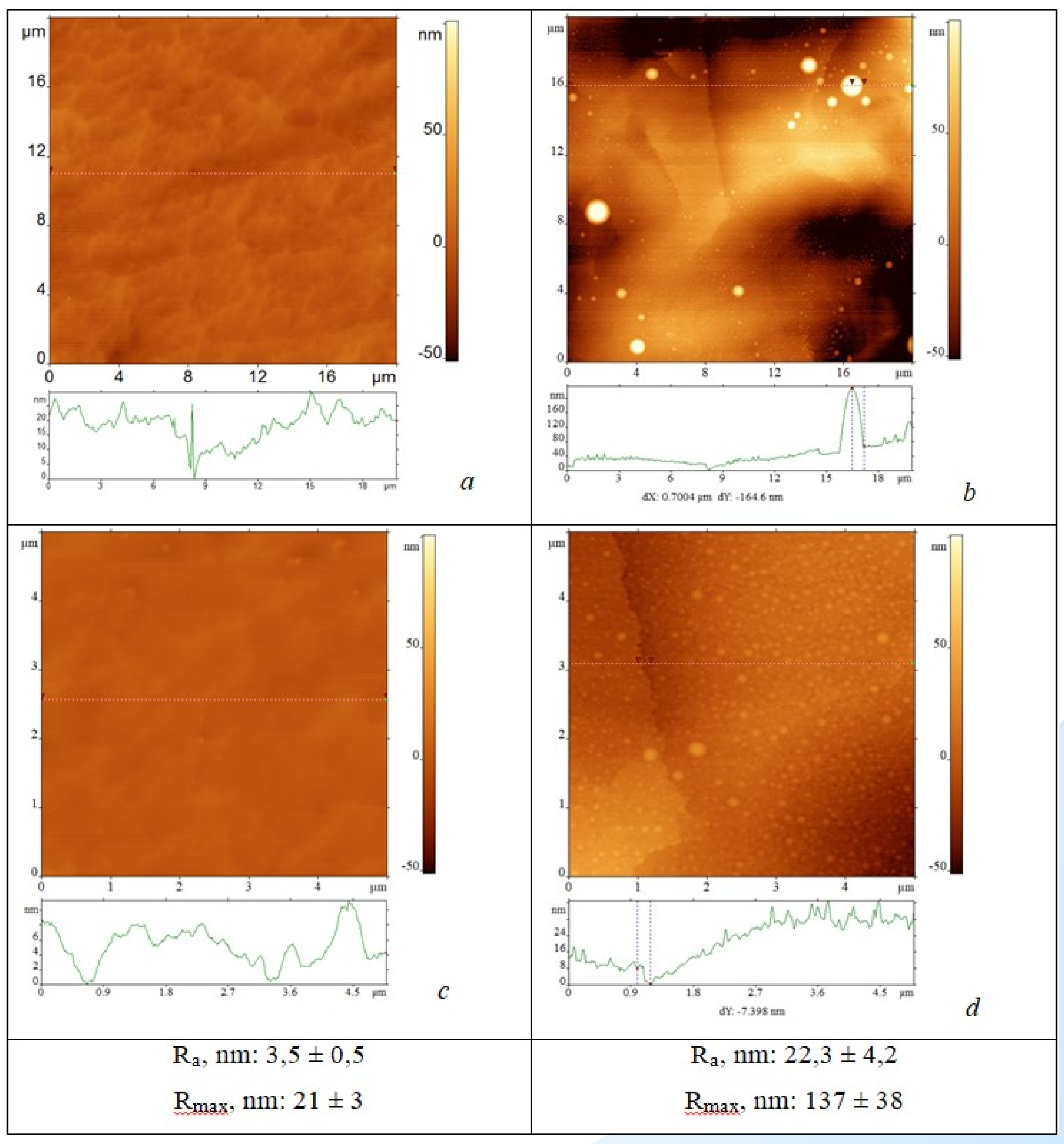
An important problem concerning the creation of new fission and fusion reactors is the development of materials for the reactor core. The operational properties of new materials should be significantly better compared to existing ones. For example, radiation resistance up to 200 dpa (displacements per atom), the ability to maintain mechanical properties at temperatures up to 700 °C, high corrosion resistance in contact with a coolant, etc. are required. Currently, in order to increase the corrosion resistance, the development of ODS steels with a high content (13 wt.% or more) of chromium has begun.

ODS steel erosion during irradiation

Weighing of irradiated samples showed an average loss of mass per pulse (erosion rate) in the range of $\Delta m \approx (0.8 – 1.5)$ .10-5 g with the number of pulse effects: N = 20 and N = 30. Conversion to the thickness of the layer evaporated in 1 pulse, according to the formula $h = 4\Delta m/\pi\rho d^2N$ (is the density of the material, d is the diameter of the irradiation zone) gives an estimated value of h (0.01 – 0.02) μm/pulse.

Number of pulses	Lattice parameter, d, Å	Crystallite size, D, Å	Internal tension, ε, %
Initial sample	2,885	1757	0,139
20 pulses	2,880	960	0,196
30 pulses	2,879	933	0,262

Lattice parameters, crystallite size, internal tension of irradiated samples



Profilometry of the surface areas of the original (a, c) and irradiated (b, d) samples of the investigated ODS steel at N = 20). One can see the preferential arrangement of spherical microparticles on the surface of the wave crests