

Polymorphous crystallization of amorphous films of Ta₂O₅

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The purpose of this work is the electron microscope study with "in situ" video recording of crystal growth in amorphous films of Ta₂O₅ and the systematization of crystallization reactions according to structural and morphological features. Amorphous films were obtained by pulsed laser sputtering of Ta targets in oxygen atmosphere. Phase transformations and structural analysis were performed by the methods of TEM, using microscopes EM-100L and PEM-100-01, operating at the accelerating voltage of 100 kV. The process of crystallization of the films was recorded from the screen of the electron microscope with Canon Power Shot G15 camera in the video recording mode with the frame rate of 30 s⁻¹.

Formation of the crystalline film took place polymorphically [1] at the constant crystal growth rate, but at different crystallization modes, that is due to local non-homogeneity of amorphous film. During layer polymorphous crystallization mode (LPC) a single crystal was formed in the region of study. A quadratic time dependence of the fraction of crystalline phase was observed and the relative length was ~ 3659.

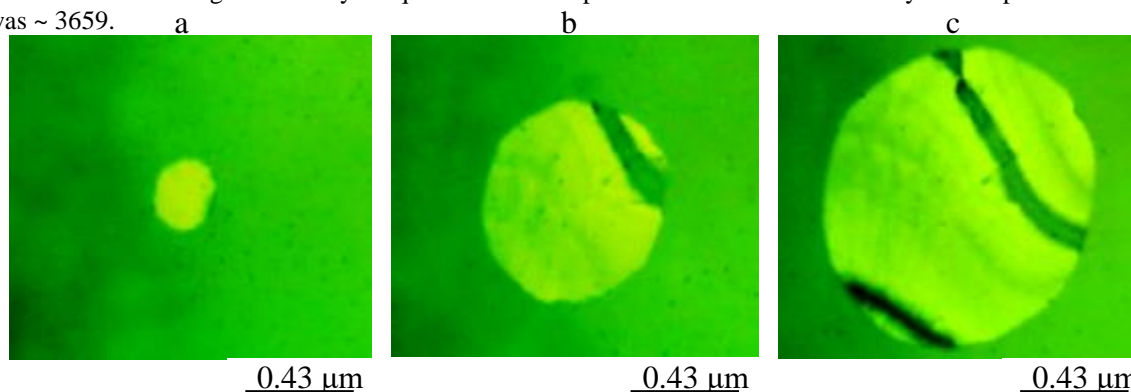


Fig. 1. Video clip frames of layer polymorphous crystallization mode of Ta₂O₅. The time moments t , which have passed from the beginning of the recording of the crystallization process: (a) $t = 2.07s$; (b) $t = 6.57 s$; (c) $t = 9.63 s$.

During island polymorphous crystallization mode, a polycrystalline film was formed in the region of study. Time dependence of the crystallization centers density was described by the curve with saturation, time dependence of the fraction of the crystalline phase had the exponential character, described by the Johnson-Mail-Avrami-Kolmogorov equation. The relative length was ~ 416.

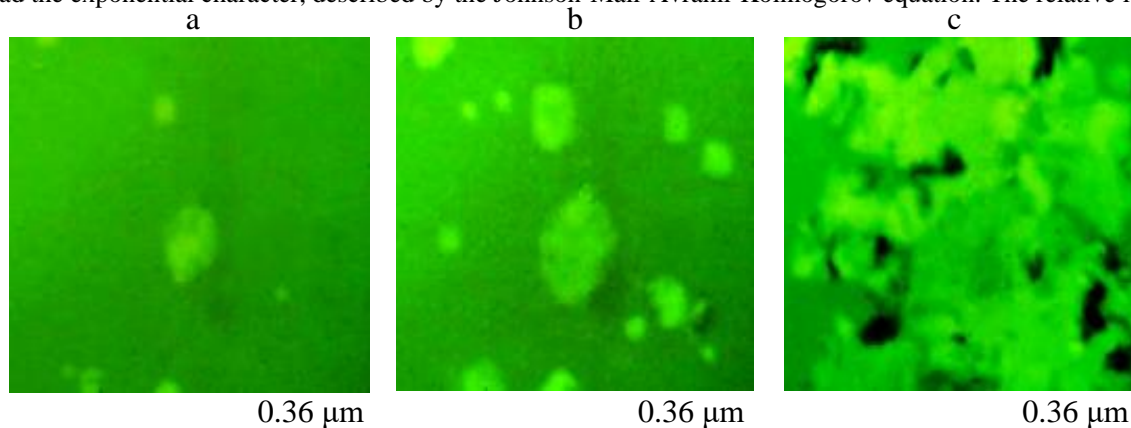


Fig. 2. Video clip frames of island polymorphous crystallization mode of Ta₂O₅. The time moments t , which have passed from the beginning of the recording of the crystallization process: (a) $t = 0.27s$; (b) $t = 0.70 s$; (c) $t = 2.23 s$.

Interjacent character of crystallization is characterized by the nucleation and growth of several (3-4) disoriented crystals. Time dependence of the fraction of the crystalline phase was approximated by the polynomial of the third power. The relative length was ~ 1783.

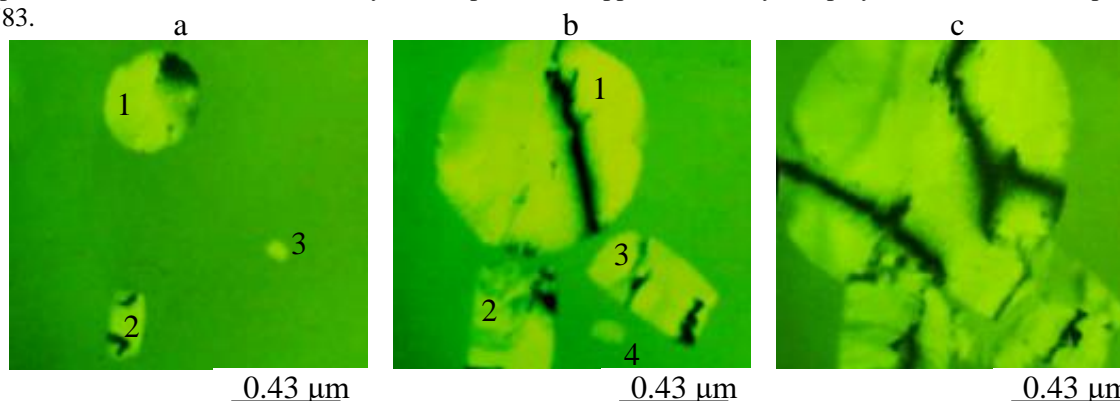


Fig. 3. Video clip frames of interjacent character of crystallization of Ta₂O₅. The time moments t , which have passed from the beginning of the recording of the crystallization process: (a) $t = 1.03s$; (b) $t = 2.40 s$; (c) $t = 3.60 s$.

1. Bagmut A. G., Bagmut I. A. Modes and kinetics of crystals growth in amorphous films of oxides // Molecular Crystals and Liquid Crystals. - 2018.- 673, P. 120-124.

