previously [1], according to which the formation of regular and pentagonal crystals is only possible if the evolution of a growing island passes via a high temperature state.

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THE POSSIBILITY OF THE OPENING OF CAVITIES IN SMALL ICOSAHEDRAL ELECTROLYTIC-METAL PARTICLES BY INCREASING THE TEMPERATURE

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Previous investigations show that a disclination is present at the center of small icosahedral electrolytic copper particles and it can lead to the formation of a cavity in them. On the basis of these investigations, an effective technique was developed for the opening of internal cavities in small icosahedral particles by chemical etching of their surface [1]. This technique underlies a filter that is a metallic mesh microframe with an adsorbing layer consisting of small metal particles with a cavity [2].

However, the chemical etching of the surface of small particles that leads to the opening of the cavity is sometimes inconvenient in applications, because it is impossible to completely remove the etchant components after the opening procedure and the presence of these components changes the adsorption properties of the mesh filter [2].

The aim of this work is the justification of alternative accessible technology for the opening of cavities in small particles and electrolytic microcrystals with six fifth-order symmetry axes.

As shown in [1], the pressure on the inner surface of a small hollow icosahedral particle that is due to the fields of elastic stresses associated with a disclination defect is given by the formula:

$$P_{ISP} = \frac{3Ga\left(1+\xi^2\right)}{10R_1\left(1-\xi^3\right)} + \frac{2G\kappa^2\left(1+\nu\right)}{9\left(1-\nu\right)} \cdot \left(1 - \frac{9\xi^3 \ln^2 \xi}{\left(1-\xi^3\right)^2}\right) \tag{1}$$

Here, $\xi = R_0/R_1$ is a dimensionless parameter, where R_0 is the radius of the cavity in the small icosahedral particle and R_1 is the outer radius of the small icosahedral particle; κ is the Marks–Ioffe disclination power; and ν - is the Poisson ratio. The maximum mechanical stress that does not lead to the destruction of the small icosahedral particle is given by the expression:

$$P_{MAX} = 2\sigma\left(1-\xi\right) \tag{2}$$

where σ is the ultimate tensile strength of the small icosahedral particle.

The possibility of the opening of a cavity in the small icosahedral particle is determined by the sign of the function $\Delta P = P_{ISP} - P_{MAX}$. If $\Delta P < 0$, pressure caused by the fields of elastic stresses associated with the disclination defect is lower than the ultimate tensile strength of the shell of the small icosahedral particle; hence, the shell does not rupture. If $\Delta P > 0$, the shell of the small icosahedral particle «opens».

The heating of the substrate or metal mesh microframe containing small icosahedral particles is proposed as a technology for the opening of the cavity in the small icosahedral particle alternative to chemical etching. The mechanical characteristics (shear modulus *G* and ultimate strength σ) of a small icosahedral particle change in the process of heating. The temperature dependence *G*(*T*) and σ(*T*) for copper are interpolated in the range *T* = 300…1000 K by polynomials on the basis of the table data presented in [3]. Then, the temperature behavior of the function:

$$\Delta P = \frac{3a\left(1+\xi^2\right)}{10R_1\left(1-\xi^3\right)} \cdot G(T) + \frac{2G\kappa^2\left(1+\nu\right)}{9\left(1-\nu\right)} \cdot \left(1 - \frac{9\xi^3 \ln^2 \xi}{\left(1-\xi^3\right)^2}\right) \cdot G(T) - 2(1-\xi) \cdot \sigma(T) \tag{3}$$

is analyzed for electrolytic copper ($a = 0.36$ nm $= 3.6 \cdot 10^{-10}$ m; $\nu = 0{,}34$; $\kappa = 0{,}12$; $R_1 = 0{,}1 \ldots 10$ μm).

As an example, Fig. 1 shows the plots of the dependences $\Delta P(\xi)$ for three temperature values. On the basis of the analysis, the «zeros» of the function $\Delta P(\xi)$ are plotted for various temperatures in the range *T* = 300–1000 K in Fig. 2. Since the zeros of the function $\Delta P(\xi)$ determine the extreme pressure on the inner shell at which it begins to open, the line of the zeros of the function $\Delta P(\xi)$ divides the (*T*, ξ) plane into two regions: the region of the stability and the region of the opening of the small icosahedral particle with respect to heating to a given temperature.

The investigations reported above justify the possibility of opening of cavities in small icosahedral particles of electrolytic copper by increasing the temperature. This fact will provide an accessible method for increasing the effective area of the surface of the absorption layer consisting of these particles deposited on various bases.

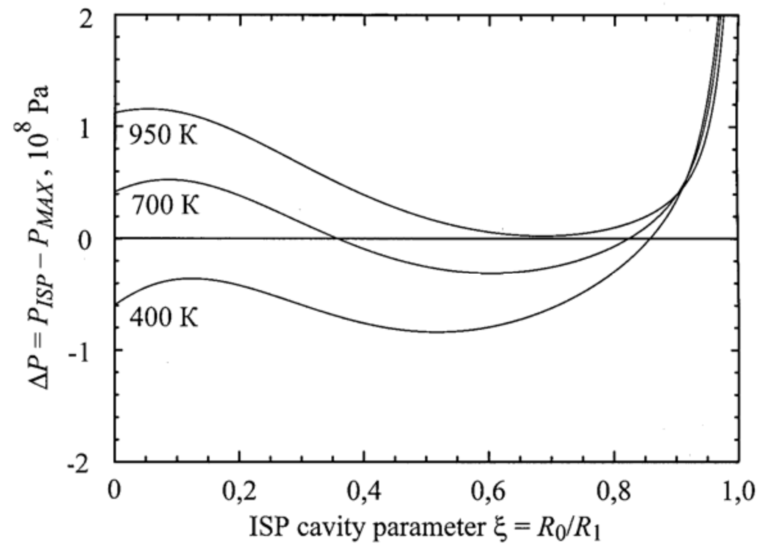

Fig. 1. Quantity ΔP vs. the cavity parameter $\xi = R_0/R_1$ of the small icosahedral particle for three temperatures.

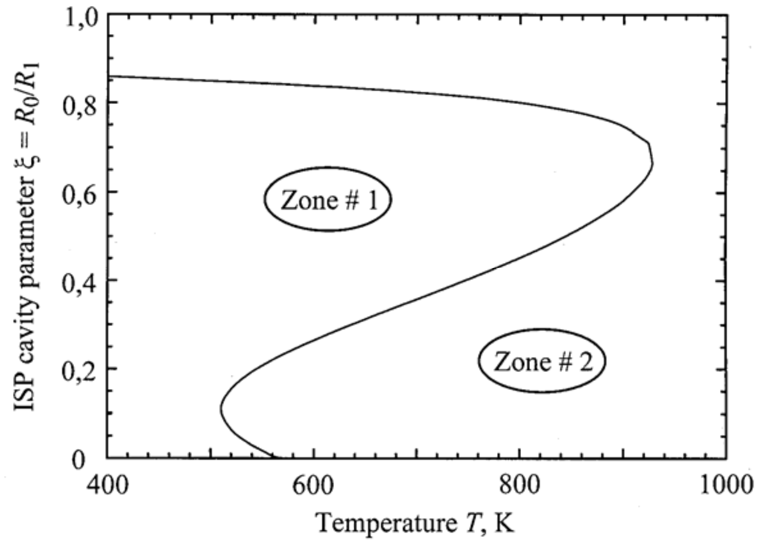

Fig. 2. Diagram of the «zeros» of the function $\Delta P(\xi)$ in a temperature range of 400–1000 K (zone 1 is the region of the stability of the small icosahedral particle and zone 2 is the region of the opening of the small icosahedral particle with respect to the heating to a given temperature).

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