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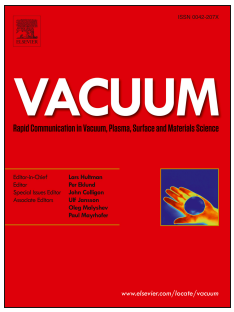

Effect of lead on the thermal dispersion of continuous polycrystalline copper films

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Effect of lead on the thermal dispersion of continuous polycrystalline copper films

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ABSTRACT

It has been found that the kinetics of heating has an essential effect on copper films dispersion temperature. Annealing of nonequilibrium defects slightly slow down the diffusion processes in comparison with unannealed samples and it naturally increases the temperature of de-wetting of continuous films. It has been shown that the formation of liquid lead in continuous Cu-Pb polycrystalline films accelerates their thermal dispersion compared to the copper films of the same thickness. Minimum concentration of lead that can stimulate de-wetting of polycrystalline copper films of 50 nm thickness, is 3 wt. %. Structural studies using electron and X-ray diffraction have shown that Cu and Cu-Pb films annealing and dispersing do not result in new phases and crystalline modifications. Only a slight increase in the solubility of the given system in comparison with bulk samples was found. The activation energy of de-wetting processes in Cu and Cu-Pb films, (which is equal to 1.6 and 0.2 eV respectively) has been determined by means of electron microscopic studies of kinetics of through pores growth. This process may be considered as the liquid phase mass transfer not the diffusive one due to the low activation energy of de-wetting for the films containing lead.

Keywords: thin film, thermal dispersion, stimulate disintegration, activation energy.

1. INTRODUCTION

When creating many modern devices it is required to form an array of individual particles that are distributed in a narrow specific size range [[1], [2]] on the surface or in the bulk of matrix. For example, in [3] it is suggested using arrays of isolated nanoparticles as effective sensors of a new generation, and in [4] similar systems are regarded as functional elements of photocatalytic generators. Metal and metal-containing nanoparticles are also used as catalysts in the synthesis of nanotubes [[5], [6]], which are gradually becoming an important element of modern technology [[7], [8]]. To form similar structures various methods, in particular chemical ones [9], have become widely used. However, they have limitations, which are primarily connected with insufficient purity of obtained objects.

In this regard, significant prospects in the development of nanoparticles arrays formation methods intrinsic to vacuum methods, in case of which it is easier to get rid of uncontrolled impurities and external contamination. Thus, in it has been shown that melting and further crystallization of films of fusible metals and alloys on the amorphous carbon substrate lead to the formation of a plurality of individual isolated particles with the shape close to spherical [10]. At the same time the change in the original film thickness enables to vary the size of the particles into which the film may be dispersed. To create an array of functional nanoparticles, thermal dispersion is used [11]. It has been shown that when annealing