METAL NANOPARTICLE PRODUCTION BY EXCIMER LASER NANOSTRUCTURING OF THIN METAL FILMS

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A novel technique, entitled excimer laser nanostructuring (ELN), for the production of supported metal nanoparticles, with controllable dimensions, from thin metal-on-oxide films, is introduced. A range of metals (Au, Ag, Mo, Ni, Ti and Zn) with differing physical and thermodynamic properties, and differing tendencies for oxide formation, are investigated. The nature of the interfacial metal-substrate interaction, the thermal conductivity of the substrate and the initial thickness of the metal film are all shown to be of importance when explaining the mechanism for nanostructuring under high fluence irradiation It is suggested that the resulting nanoparticle size distribution is influenced the surface roughness of the initial film and the Rayleigh instability criterion. The results obtained are compared with simulations of the heat transfer through the film in order to further elucidate the mechanisms. The results are expected to be applicable to the laser induced melting of a large range of different materials, where poor wetting of substrate by the liquid phase is observed.

After discussing the mechanisms, we introduce two applications for these nanostructured films. The first application is the production of Ni islands, with controllable dimensions, for the catalytic growth of carbon nanotubes[1]. Example of these Ni nanoparticles is shown in figure 1. In the second application, the ELN of silver thin films was employed to produce nano-structured Ag/SiO_2 substrates over large area, at room temperature, suitable for performing surface enhanced Raman spectroscopy (SERS). Figure 2 shows a Ag nanoparticle array prepared by ELN. After processing, the substrates were used to perform SERS measurements on ultra-thin diamond like carbon coatings to determine how the carbon-bonding configuration varied with film thickness.

References

[1] S. J. Henley, C. H. P. Poa, A. A. D. T. Adikaari, C. E. Giusca, J. D. Carey and S. R. P. Silva, Appl. Phys. Lett. **84**, 20 (2004)

Figures:

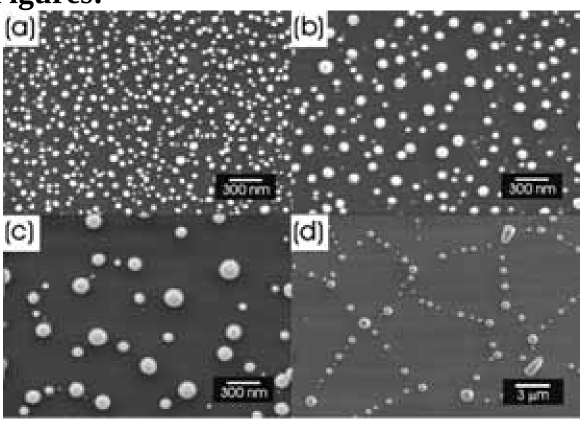

Fig 1. SEM images of ELN Ni films with different thicknesses. (a) 6.5 nm thick film (b) 8.2 nm (c) 11.5 nm and (d) 15 nm.

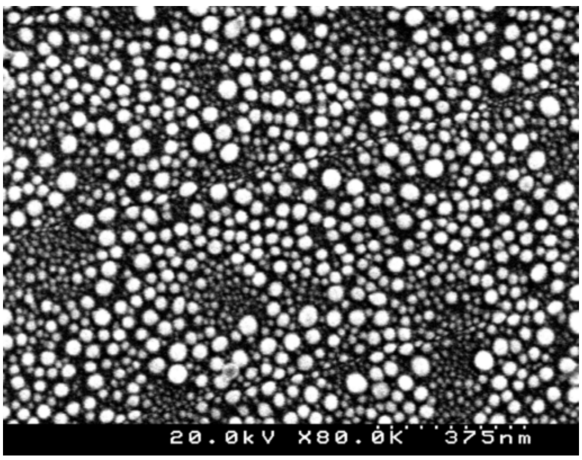

Fig 2. Ag nanoparticle array