**Helical and square-spiral copper nanostructures:**

**The effect of thickness and deposition conditions on the structural and optical properties**

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We have investigated the effect of thickness and deposition conditions on the structural and optical properties of nanostructured copper (Cu) thin films, deposited using e-beam glancing angle deposition. In the first series of experiments, samples were deposited in the form of helical nanostructures, to the thicknesses of 160 nm, 280 nm, 450 nm and 780 nm. The second set of the samples was fabricated in the form of zigzag and square-spiral nanostructures to a thickness of approximately 300 nm, by using different azimuthal rotations (φ = 180o, 90o, 45o, 22.5o and 11o). Field-emission scanning electron microscopy and high-resolution transmission electron microscopy were utilized to explore morphological and structural properties, while optical studies were done using spectroscopic ellipsometry.

The results showed that for both series of the samples the deposited structures are porous with nanometer-sized particles. Detailed analyses of optical properties revealed that the thickness of the films had a significant impact on the dielectric function of Cu structures. With increasing the thickness from 160 nm to 780 nm the surface plasmon resonance (SPR) peak was shifted from 1.31 eV to 1.05 eV. Changes in SPR peak position were associated with the growth mechanism and the size of deposited nanostructures. For the second series of the samples, it was found that as the azimuthal rotation decreases, deposited nanostructures become more porous with larger number of grown arms. Optical analysis showed that the properties of the grown Cu films are greatly influenced by the deposition conditions. By decreasing the φ parameter, SPR peak was shifted from 1.19 eV to 0.75 eV, which can be correlated with the size distribution and agglomeration of Cu nanoparticles.