Preparation of PMMA/Cu-Nanocomposites by pulsed laser deposition

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Layered polymer/metal nanocomposites consisting of poly(methyl methacrylate) PMMA and Cu were deposited by pulsed laser deposition (PLD) at room temperature by alternatively switching the target from PMMA to Cu. At this, for PMMA a laser fluence of 60 mJ/cm^2 close to the deposition threshold was used to obtain a smooth polymer film without droplets [1], while for Cu a laser fluence of 6 J/cm^2 had to be taken. On the smooth polymer layers, the metal grows in Vollmer-Weber island growth leading for thin Cu-films to layered PMMA/Cu nanostructures with spherical metallic particles as shown in Fig. 1a. The growth mechanisms of metal islands on laser deposited polymers was described earlier in [2, 3]. For larger metal layer thicknesses, the metal layers are closed and PMMA/Cu multilayers are formed (Fig. 1b).

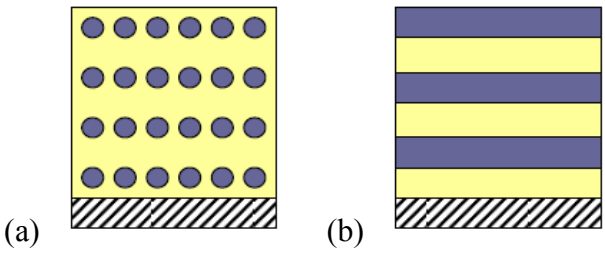

Fig. 1: Layered polymer/metal-nanocomposites as investigated (schematically)

The composition of PMMA was studied by infrared spectroscopy (FTIR). The PMMA/Cu nanostructures were analyzed by X-ray reflectometry in order to investigate the periodicity and interface roughnesses of the layered structures. Atomic force microscopy (AFM) was used to study the surface morphology. Cross section slices of the layered structures cutted by focused ion beam (FIB) were examined by electron microscopy (SEM, TEM).

It was found that indeed well layered PMMA/Cu-structures can be formed by PLD, but stress formation leeds to buckles and waves of the metal layers as long as the PMMA layers are weak. Therefore, partial cross-linking of the PMMA-layers (obtained for instance by UV-radiation) is necessary to obtain polymer layers with increased hardness and smooth metal layers.

In this contribution, the properties of these periodic structures is discussed with respect to individual layer thicknesses, roughnesses and periodicities, stress formation within the Cu-layers and cross-linking of the polymer.

[1] B. Lösekrug, A. Meschede, and H.U. Krebs, *Pulsed laser deposition of smooth poly(methyl methacrylate) films at 248 nm,* Appl. Surf. Sci., 254 (2007) 1312.

[2] J. Röder and H.U. Krebs, *Tuning the microstructure of pulsed laser deposited polymer-metal nanocomposites*, Appl. Phys. A 85 (2006) 15.

[3] J. Röder, J. Faupel, and H.U. Krebs, *Growth of polymer-metal nanocomposites by pulsed laser deposition*, Appl. Phys. A 93 (2008) 863.