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Morphological and structural modifications induced in ultrathin metallic films by nanosecond pulses from EUV laser-plasma source

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Laser-induced ablation from a solid target is known as an alternative physical method for nanofabrication. The most recent effort includes using plasmonic metal nanoparticles to improve the efficiency of quantum dot solar cells and thin film solar cells [1,2].

The main difference between nanofiber and other nanostructures (nanowire, nanotube, and nanorod) in solar cell application is the well-organized morphology structure [3].

In the present study a various number (up to 1200) of extreme ultraviolet (EUV) pulses have been used to create nanostructures at thin gold film of 80-nm thickness initially deposited onto a silicon (100) wafer using MBE technique.

The source was a 10 Hz laser-plasma source based on a double-stream gas puff target created in a vacuum chamber synchronously with the pumping laser pulse. The target is formed by pulsed injection of Kr, Xe or a KrXe gas mixture into a hollow stream of helium. The EUV radiation is focused using a grazing incidence gold-plated ellipsoidal collector. Spectrum of the reflected radiation consists of a narrow feature with intensity maximum at 10–11 nm.

After irradiations, the samples were characterized by means of the interference-polarized microscopy, scanning electrical microscopy (SEM), atom force microscopy (AFM) and synchrotron X-ray diffraction (SXRD).

Various numbers of laser interaction pulses were used to control the synthesis of the nanofibrous structures. The preliminary analysis revealed that the nanostructures are formed due to the aggregation of nanoparticles with diameters varying between 30 and 90 nm. With increasing number of irradiating pulses the nanoparticles have a tendency to aggregate and merge into spheres.

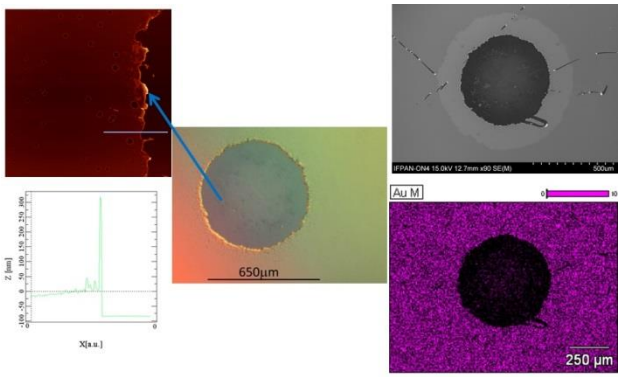

Figure 1. Exemplary results of surface modifications studies, obtained for 80nm Au film deposited on silicon irradiated with a single EUV pulse. 1) center: interference-polaizing microscopy image, 2) upper left: AFM map near the crater edge area, 3) bottom left: height profile along a line crossing the crater edge, 4) upper right: SEM image of the crater, 5) bottom right: X-Ray Fluorescence map (Au M-emission line) of the crater.

At higher number of pulses they form entangled fibrous nanostructures. The basic mechanism of laser synthesis of nanoparticles could be explained by the accumation of the dense cloud of atoms around the laser spot of the gold target during the ablation [4-6].

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[1] Aren't *et al., Nano Lett.* **12** (2012) 4070.
[2] Jiang *et al., Sol Energy Mater Sol Cells* **102** (2012) 44.
[3] Mahmood *et al., Nanoscale Res. Lett.* **9** (2014) 255.
[4] Manickam *et al., Opt. Exp.* **17** (2009) 13869.
[5] Tan *et al., Opt. Exp*. **17** (2009) 1064.
[6] Amirkianoosh *et al., Nanoscale Res. Lett*. **7** (2012) 518.