Laser-generated acoustic waves in tungsten thin films with oriented nanostructure

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There is a growing interest in the deposition of thin films with oriented nanostructure by glancing angle deposition (GLAD), i.e., using oblique incidence of particles [1]. The films with different types of columnar nanostructure can be sculptured by GLAD. However even the films, which are not intentionally structured, exhibit spatial inhomogeneity at nanoscale, which manifests itself for example in the variation of the columns orientation from the bottom towards the top of the film. Here we report preliminary results on the evaluation by the picosecond ultrasonic technique of tungsten 100 nm-thick films deposited by GLAD sputtering on glass, silicon (100) and diamond substrates. Incidence angle of sputtered W atoms was 80° leading to a column angle of 35-40°. The coherent acoustic waves were generated by picosecond pump laser pulses incident on W films. Both the acoustic eigenmodes of the film and the acoustic waves launched in the substrate were detected by picosecond probe laser pulses. Particular attention was devoted to revealing (i) shear acoustic waves excitation and (ii) film inhomogeneity influence on the acoustic eigenmodes spectrum; the former being indeed expected due to film anisotropy and inclination of columnar nanostructure relative to the substrate surface orientation [2]. The information on nano-acoustic waves generation and propagation in these films could be useful for their depth-profiling and for testing theoretical models existing for the prediction of anisotropic elastic behaviors of complex tilted porous nanostructures [3].

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