Mechanical characterization of nanostructured tungsten films for nuclear applications

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Due to their use as a shield and structural component plasma facing materials have to fulfil very different requirements: from the stability with respect to high neutron irradiation doses to the ductility within the operation temperature range.

Owing to its low sputtering yield and good thermal properties, tungsten seems a promising candidate material for plasma-facing components in next nuclear fusion devices. For practical applications, tungsten coatings are being assessed for use instead of bulk tungsten components solving the problem of heavy weight of W.

In order to investigate the technological feasibility of a W coating on a first wall structure, nanostructured tungsten thin films were deposited onto stainless steel, molybdenum and silicon substrates by DC magnetron sputtering. The characteristics of the film properties such as adhesion, grain size and morphology have been investigated by Scanning Electron Microscopy (SEM), while the mechanical response of the different coating-substrate systems was characterized using the nanoindentation and nanoscratch techniques.

The cross-sectional SEM images revealed that the films morphology is formed by columnar grains with and average grain size of 100 nm. Hardness values deduced from nanoindentation curves by statistical average on each sample is 14 GPa for all the films deposited, three times larger than the one reported for coarse-grain W.