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Preparation and sputtering-resistant property of nanocrystalline molybdenum films for first mirrors

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First mirrors are expected to play a crucial role in the optical diagnostics of ITER to view the burning plasma. Taking into account the fact that first mirrors must serve in the highly harsh environment due to their proximity to burning plasma, the material selection of first mirrors is therefore a critical and challenging issue. Highly reflective nanocrystalline molybdenum (Mo) coating on metal substrates with high thermal conductivity is considered as one of the most promising materials of first mirrors in terms of their production cost and decent sputtering-resistant property.

In our work, a stainless steel 316 bulk was mechanically polished to a high finish and was subsequently coated with the nanocrystalline molybdenum film via the direct current magnetron sputtering. The surface morphology and optical reflectivity of the thin film were measured by scanning electron microscope (SEM), atomic force microscopy (AFM) and spectrophotometer. It was found that the thickness of the thin film was about 300 nm with the roughness of 1 nm. XRD pattern clearly shows the peaks of Mo. The crystal grains were periodically arranged and the calculated grain size was around 4 nm. Compared with a bulk Mo mirror with a grain size of a few tens of micrometers, the significant enhancement of the specular reflectivity of the thin film was observed in the range of ultra and visible wavelength, even reaching 15% at 250 nm.

The nanocrystalline Mo coating was sputtered by radio frequency argon glow plasma with an electron density of 7×10^{14} m^{-3}, electron temperature of 2 eV and the duration time of 30 minutes. The sputtering test was performed with an argon pressure of 0.5 Pa, self-bias of -200 V which were specifically set as the same scenario as in-situ cleaning of ITER. The relevant results will be presented in the near future.