Advancements in the growth of Boron based films using ns and fs pulsed laser deposition

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Due to its unique crystalline structure boron based materials exhibit very interesting mechanical, optical and thermoelectric properties that find application in various fields of science and technology. Thanks to its affinity with oxygen, boron has been used in magnetic nuclear fusion research as wall conditioning on many tokamaks, achieving in this way a remarkable improvement in plasma performances. Coatings containing boron are widely used in the field of nuclear physics. In fact, boron is involved in two nuclear reactions, 10B(n, α)7Li and 11B(p, 3α), that are widely studied in the fields of neutron detection and nuclear fusion [1,2].
Among the deposition techniques Pulsed Laser Deposition (PLD) is very interesting due to its higher deposition rates compared with RF-sputtering and the reduced number of droplets compared with unfiltered cathodic arc. Nevertheless, an accurate tailoring of the process parameters is necessary for the deposition of coatings and nanoparticles reliable for applications [3, 4]. In addition to the conventional nanosecond ablation regime, it is also possible to deposit boron films using femtosecond PLD. The femtosecond regime induces the formation of nanostructured films constituted by nanoparticles. Such structure is the result of the different ablation physics of this regime [5].
Here we present and discuss the features of boron films deposited by ns- and fs- PLD addressing the role of process parameters (laser fluence, background pressure, target to substrate distance and presence of background gas) and highlighting the wide array of coatings that can be obtained. Films are characterized by X-Ray Diffraction, Raman, SEM and EDXS. Mass density is assessed by the elaboration of EDXS measurements through the EDDIE code [6]. Film features (structure, density, morphology, oxygen content and number of droplets) are critically determined by the process parameters and the chosen laser ablation regime.
The nanosecond regime leads to the growth of compact, amorphous films with a smooth surface for which it is possible to tailor oxygen content and internal stresses. Conversely, the femtosecond regime leads to the deposition of nanoparticle assembled coatings with 2000 – 20 mg/cm^3 density and deposition rate up to 7,6 μm/min.

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