



Preparation and properties of longevity-enhanced high-quality Al₂O₃ and its composite Al₂O₃/Er₂O₃ TPB coatings

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Tritium permeation barrier (TPB) coating is one of the key scientific and technological issues for tritium safety and tritium self-sufficiency area for future fusion experiment/engineering reactors^[1,2]. It is one of the most effective methods to reduce tritium permeation by preparation of TPB coating on the surface of tritium-involved structural components, connecting pipelines, and containers in tritium breeding blanket and tritium plant in the reactor^[1,3,4]. And it has become a research hotspot in the field of fusion reactor materials. Study on preparation of longevity-enhanced high-quality Al₂O₃ and its composite Al₂O₃/Er₂O₃ TPB coatings is carried out here.

Al₂O₃ and its composite Al₂O₃/Er₂O₃ TPB coatings are synthesized using RF (13.56MHz) magnetron sputtering which belongs to low temperature plasma physical vapor deposition. The films are deposited from sintered ceramic target (purity of 99.99%) of 60 mm in diameter, and the distance between target and substrate is 8 cm. High purity argon (purity of 99.99%) is used as carrier gas. The base pressure is below 5.5×10^{-4} Pa. The parameters including power, working pressure, gas flow, sputtering time are variable. The polished 316L stainless steel, Si and quartz glass are used as substrates after a careful and strict RCA cleaning process. The deposition process is under room temperature. The characterization of surface morphology, physical structure is

systematically investigated by using XRD, SEM and AFM. The composition and chemical bonding of the films is investigated by using XPS and FTIR. The thickness and refractive index are investigated by using spectroscopic ellipsometry. The optical transmittance properties of the films are recorded by ultraviolet-visible spectrophotometer. Moreover, study on thermodynamic and mechanical properties (such as thermal mismatch and adhesion strength), tritium (hydrogen isotopes) permeability properties is also investigated. Combined with the various characterization results and properties, the optimum preparation parameters of TPB coatings can be obtained.

Keywords: TPB coating, Al₂O₃, magnetron sputtering

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