FABRICATION AND CHARACTERISTICS OF GRADED-PERMITTIVITY TITANIA COATINGS*

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Nowadays, with the increase of the voltage level and capacity of electrical equipment (e.g., in power transmission grids or pulsed power devices, etc.), the electrical insulation often fails when high electric fields are generated [1]. Functionally graded materials (FGMs) exhibit unique properties and have application potential at extreme conditions [2-3]. Here, in order to improve the electrical insulation of conventional materials, a simple fabrication method of FGM with two-phase-interfaced, graded-permittivity titania (TiO_2) by an atmospheric pressure plasma deposition.

As shown in Fig.1, FGM structure is composed of rutile (ε_r=110) and anatase (ε_r=48) layers of TiO_2, as well as the original ceramic layer (ε_r=9). Meanwhile, the optimized deposition conditions of anatase and rutile layers of TiO_2 are determined, respectively. Compared with the original samples, the maximum electric field along the surface of FGM decreased by 66%, and the surface flashover voltage of FGM in vacuum is increased by 36%. Also, the insulating performances of FGM have long-term stability. The increase of surface flashover voltage results from the electric field relaxation effect caused by the gradient distribution of permittivity in the designed FGM [4]. Next, with further optimizing the FGM structure, it is expected to further improve the surface-insulating performance of FGM at industry-relevant scales, thereby nearing the real-world industrial applications of the novel interface-engineered materials in diverse fields. To this end, a movable jet array and continuous processing will need to be developed further to scale up the plasma processing and improve the processing efficiency.

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