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Recent advance in functionally graded materials prepared by atmospheric pressure plasma

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Recently, 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. For example, once the surface flashover occurs in power transmission lines, with currents up to ~ kA, the electrical equipment may burst into flames or explode by overheat, which is hazardous and detrimental to power system safety.[1] Therefore, a novel functionally dielectric material is urgent to develop.

Since the good flexibility and economy, atmospheric pressure plasma has potential application in material modification and preparation.[2,3] Such as the material modification can regulate the insulating performance of solid dielectric. Moreover, functionally graded materials (FGMs) exhibit unique properties and present excellent performance at extreme conditions (e.g. high electric field).

Here, a simple preparation method of FGM with two-phase-interfaced, graded-permittivity titania (TiO_2) by an atmospheric pressure plasma deposition. When this FGM is applied in high electric field, the distortion of surface electric field is optimized. The maximum electric field along the surface of FGM decreased by 66%, thus, the surface flashover voltage of FGM is increased by 36%. Namely, the FGM with high surface insulating performance is prepared by atmospheric pressure plasma successfully. Also, the mechanisms of the plasma-enabled graded layer formation are presented, which can be used for precise engineering of FGMs for diverse applications in other fields.

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References

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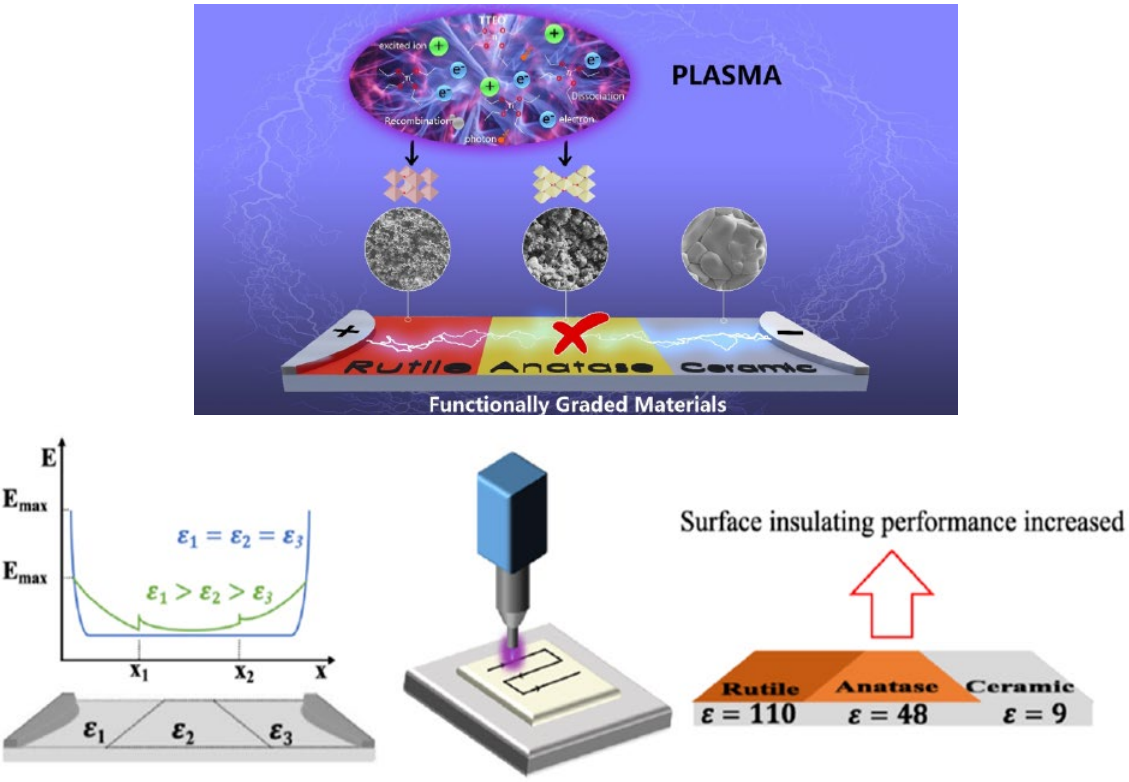

Figure 1. FGM with two-phase-interfaced, graded-permittivity titania (up) and schematic of atmospheric pressure plasma deposition (down)