MgO insulating films prepared by sol-gel route for SiC substrate

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Abstract

Silicon carbide (SiC) is a wide bandgap semiconductor suitable for high-voltage, high-power, and high-temperature devices from DC to microwave frequencies. However, the commercialization of advanced SiC power devices remains limited due to performance limitation of the SiO_2 dielectric among other issues. Indeed, SiO_2 has a dielectric constant 2.5 times lower than that of SiC, which means that at critical field for breakdown in SiC, the electric field in the adjoining SiO_2 becomes too high for reliable operation. This removes the main advantage of using SiC power devices if the ten times higher breakdown field for SiC in comparison to Si cannot be exploited. Therefore, alternative dielectrics having a dielectric constant higher than or of the same order as that of SiC ($\varepsilon_r \approx 10$) should be used to reduce the electrical field in the insulator. Among alternative dielectrics to silicon dioxide (SiO_2),

magnesium oxide (MgO) seems to be a good candidate regarding its bulk properties : large bandgap, high thermal conductivity and stability, and a suitable dielectric constant ($\varepsilon_r \approx 10$). In order to evaluate such promising candidate, the sol-gel process appears to be a convenient route to elaborate this kind of coatings. By selecting appropriate precursor solution and optimizing the curing conditions of the films, MgO films could be obtained under various crystallization states : non-oriented and preferred [111] orientation. MIM structures have been used to investigate the insulating potentialities of the sol-gel MgO films. The dielectric strength of the films was found to be microstructure dependent, and reached 5 to 8 MV/cm at room temperature. Leakage currents were measured from 25°C up to 250°C.

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