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High-performance $(1-x)(0.2\text{B}_2\text{O}_3-0.8\text{SiO}_2)-x\text{TiO}_2$ ($x = 0.025-0.1$) glass matrix composites for microwave substrate applications

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ABSTRACT

The $(1-x)(0.2\text{B}_2\text{O}_3-0.8\text{SiO}_2)-x\text{TiO}_2$ ($x = 0.025-0.1$) glass matrix composites were prepared by a solid state sintering method, and high relative density >97% was obtained when the sintering temperature was 975–1000°C. The rutile and amorphous phases were indicated by XRD, and no crystallization of amorphous SiO_2 or chemical reaction was observed. With increasing x from 0 to 0.1, the dielectric constant (ϵ_r) increased slightly while the Qf value decreased, and the temperature coefficient of resonant frequency (τ_f) increased from a negative to a positive value. The optimized microwave dielectric properties were obtained as following: $\epsilon_r = 4.01$, $Qf = 66,800$ GHz, $\tau_f = -2.2$ ppm/°C for $x = 0.025$ sintered at 1000°C, and $\epsilon_r = 4.22$, $Qf = 55,300$ GHz, $\tau_f = 3.1$ ppm/°C for $x = 0.05$ sintered at 975°C. The ultra-low ϵ_r , high Qf value and near-zero τ_f indicate that the present glass matrix composites are excellent candidates as the microwave substrate materials.

KEYWORDS: glass matrix composite; fused silica; microwave substrate

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