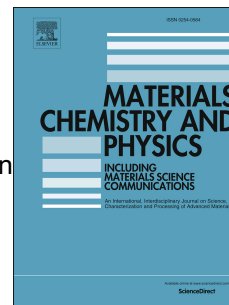


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Nonlinear Absorption and Refraction Studies of Truncated CuNb_3O_8 with High-repetition Rate Femtosecond Pulses

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Abstract

Copper niobate with CuNb_3O_8 composition was prepared via one-step solid state reaction (750 °C, 12 hours). Powder X-ray diffraction (XRD) confirmed the formation of parental CuNb_2O_6 phase with traces of CuNb_3O_8 on initial sintering (till 9 hours), which was then transformed into pure CuNb_3O_8 on higher sintering (12 hours). Field emission scanning electron microscope studies (FESEM) illustrates the formation of truncated cubes due to unification of layered structure upon prolonged heating. Third-order nonlinear optical properties of truncated CuNb_3O_8 was studied by Z-scan technique using Ti: Sapphire laser (800 nm, 150 fs, 80 MHz). Pure CuNb_3O_8 possessed strong nonlinear absorption (two-photon absorption coefficient of 5.3×10^{-10} m/W) and nonlinear refractive index n_2 (2.1×10^{-16} m²/W) compared to mixed copper niobate (CuNb_2O_6 - CuNb_3O_8). The third-order nonlinear optical susceptibility of CuNb_3O_8 was $\sim 10^{-11}$ esu and was higher than the known nonlinear optical (NLO) systems such as lithium niobate and sodium niobate measured at similar pulse duration. Enhancement in nonlinearity arises due to the influence of morphology and here truncated cubes with the platonic solids offer high polarizability as the charges are concentrated in the edges of the system. The truncated cube CuNb_3O_8 exhibited strong optical limiting action with a low limiting threshold ($34.6 \mu\text{J}/\text{cm}^2$), thus making it appealing for ultrafast optical limiter devices towards photosensitive component protection from Infrared (IR) laser damage.

Keywords: Copper Niobate, Femtosecond, Z-scan, Two-photon Absorption

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