The Effect of Size and Structural Modification in $BaTiO_3$ Particles Second-Harmonic Generation

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Ferroelectric materials, especially at the micro and nanoscale, have garnered significant attention due to their nonlinear optical (NLO) harmonic generation capabilities [1,2]. These properties are essential in photonics research and have potential applications in innovative sensing and imaging techniques across materials science and chemistry [3]. One of the key techniques in nonlinear optics is the optical second harmonic generation (SHG). Perovskite particles, such as $BaTiO_3$, are a focal point in this domain [4]. Their non-centrosymmetric crystal structure at both micro and nanoscales gives them distinct properties. In this context, we study the dispersion of SHG at three different sizes (340, 430 and 1040 nm) in $BaTiO_3$ nanoparticles by using the tunable femtosecond hyper Rayleigh scattering (HRS) technique at the range from 1064 to 1500 nm. Our outcomes show that larger particles have higher second-harmonic values when normalized by volume. So, through Raman spectroscopy and X-ray diffraction, we identified a systematic blueshift in Raman modes and pronounced lattice strain due to thermal treatment that promotes the enhancement of tetragonality at larger particles. Consequently, this led to a noticeable variation in the second-harmonic values when normalized by volume increased until two-fold. These findings reinforce the potential of $BaTiO_3$ in revolutionizing optical and medical imaging applications and accentuate the significance of meticulously adjusting its structural parameters.

References

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