RADIATION EFFECTS & DEFECTS IN SOLIDS
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Laser irradiation effects on the dielectric properties of zinc ferrite at room temperature

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ABSTRACT

Zinc ferrite (ZF) nanomaterials were synthesised by the sol–gel auto-combustion method. Synchrotron-XRD confirms the formation of the pure F-d3m spinel structure whereas EDX reveals the composition of synthesised nano ZF. We investigated and compared the dielectric properties of un-irradiated pellet ZF-UI and irradiated pellets ZF-I1 (pulsed Nd:YAG laser dose of 1.2 W, $\lambda = 1064$ nm), ZF-I2 (pulsed Nd:YAG laser dose of 1.5 W, $\lambda = 532$ nm) and ZF-I3 (continuous AlGaAs diode laser of 4 W, $\lambda = 808$ nm) at room temperature. Dielectric constant (ε') decreased prominently for ZF-UI while it decreased gradually for ZF-I1 and its decrement for ZF-I2 and ZF-I3 is very slow whereas dielectric constant (ε'') decreased prominently for ZF-UI and ZF-I1while reduced slowly for ZF-I2 and ZF-I3 in the low-frequency region. ε' becomes $\sim$69% for ZF-I1 and $\sim$9% for ZF-I2 and ZF-I3 at a higher frequency of 2 MHz whereas ε'' for radiated samples becomes steady and nearly equitable at higher frequencies in comparison to that of ZF-UI in the measured frequency range of 10 kHz to 2 MHz. Dielectric loss (tan δ) of all irradiated samples has decreased and become $\sim$33% for ZF-I3, 43% for ZF-I2, nearly equal for ZF-I1 at 10^4 Hz and then decreased continuously up to 2 MHz when compared to tan δ for ZF-UI. The Jonscher power law has been fitted in measured ac conductivity (σ_{ac}) with angular frequency (ω) graphs. DC conductivity (σ_{dc}), temperature-dependent parameter $B(T)$ and frequency exponent (n) have been extracted. σ_{dc} for all irradiated samples has decreased and become nearly 51% for ZF-I1, 3% for ZF-I2 and 2% for ZF-I3 in comparison to that of ZF-UI whereas $B(T)$ increased to 1.6 times for ZF-I3 and decreased to 0.7 times for ZF-I1 and 0.2 times for ZF-I2 while n shows slight decrement for ZF-I2 and ZF-I3. Interpretation from Cole–Cole plots for un-irradiated and irradiated pellets is in agreement with our investigations. These results suggest that the dielectric properties of ZF can be controlled and tuned by laser irradiation.

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