Bulk and Surface Excitations in Gd$_2$O$_3$: Electron Energy Loss Spectroscopy Study

S.C. LIOU, M.-W. CHU, C.H. CHEN, CCMS, NTU, Taiwan, Y.J. LEE, M. HONG, Dep. MSE, Hsinchu, Taiwan, J. KWO, Dep. Physcs, Hsinchu, Taiwan — Gd$_2$O$_3$ with its high dielectric constant ($\kappa \sim 14$), large band gap (5.4 eV) and thermodynamic stability has featured prominently in the literature as an effective passivation in GaAs substrate to fabricate the metal-oxide-semiconductor field-effect transistors (MOSFETs) and promising candidates for future scaling of CMOS technology. Here, we report studies of electronic excitations of Gd$_2$O$_3$ in cubic phase by electron energy-loss spectroscopy (EELS). EELS spectra in bulk Gd$_2$O$_3$ reveal several broad spectral features above the optical band gap at $\sim 7.5$, $\sim 15$, $\sim 17.5$, $\sim 27.5$, $\sim 31.5$ and $\sim 36$ eV. We have obtained the dielectric function by performing Kramers-Krönig analysis. The 15 eV peak is identified as bulk-plasmon excitation. The 13.6 eV peak, which is visibly enhanced at thinner areas, arises from excitation of surface-plasmon. The other features at $\sim 7.5$, $\sim 17.5$, $\sim 27.5$, $\sim 31.5$ and $\sim 36$ eV result from bulk interband transitions. Moreover, we note that the 7.5-eV peak associated with interband transition also bears a strong character of surface excitations, as evidenced by measurements carried out in a loaf geometry. Detailed characteristics of this unconventional surface excitation will also be discussed.

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