Correlation between bulk magnetoelectricity and boundary magnetization in Cr$_2$O$_3$ JUNLEI WANG, CHRISTIAN BINEK, University of Nebraska-Lincoln — Boundary magnetization is a roughness insensitive net magnetization. It emerges at the surface or interface of a magnetoelectric antiferromagnet in a single-domain state and has been utilized in voltage controlled spintronic system for potential ultra-low power application based on exchange bias system with Cr$_2$O$_3$. Previous work has lacked to demonstrate the direct relation between the bulk spin structure and the boundary magnetization. In this work, we use magneto-optical Faraday effect to observe boundary magnetization and correlate it with the bulk magnetoelectric response of a Cr$_2$O$_3$ single crystal on an applied electric field, $E$. Our method discriminates the $E$- dependent bulk Faraday rotation, $\theta$, from the stationary boundary magnetization. To this end we investigate $\theta$ vs. $E$ in two distinct antiferromagnetic single-domain states which are prepared via magnetoelectric annealing. Temperature dependence of the boundary magnetization, $m_{BM} \propto \Theta(E = 0)$, as well as the corresponding bulk magnetoelectric susceptibility, $\alpha \propto d\Theta/dE$, is obtained from separate investigations of $\theta$ vs. $E$ for the two single domain states. Our magneto-optical setup uses a near-infrared laser so that transmission loss is admissible for our sample of 500 $\mu$m thickness. We utilize lock-in and compensation techniques to maximize measurement precision and to enable absolute Faraday rotation measurement which is gauged with respect to magnetization.

Junlei Wang
University of Nebraska