

Magneto-electric optical effects in copper metaborate

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Copper metaborate, CuB_2O_4 , is a non-centrosymmetric tetragonal system with a space group $I-42d$. The cuprate has a transparent blue color due to the intra-atomic $d-d$ transitions at Cu^{2+} ions. The compound undergoes successive magnetic transitions at 20 K and 9 K.

In the intermediate-temperature phase between 9 K and 20 K, the magnetic moments on Cu(A) sites with a square planar coordination are antiferromagnetically aligned and slightly canted through DM interaction. The non-centrosymmetric weak ferromagnet exhibits several interesting coupling among magnetic, electrical, and optical properties. For example, It exhibits directional dichroism, which is a kind of optical ME effects, for linearly polarized light propagating along the $[110]$ axis in the crystal with magnetization along the $[1,-1,0]$ axis. The optical absorption at 1.405 eV shows a large change by a factor of three with the reversal of magnetization direction, which is equivalent to the reversal of the light propagation.

When the magnetization orients along the $[1,0,0]$ axis, it exhibits a similar directional dichroism for the light propagating along the magnetization, also views as magneto-chiral anisotropy, at 1.405 eV. Below the absorption line fairly large directional birefringence also appears. We recently confirmed the presence of the so-called “Lorentz force” in a Ni-doped copper metaborate crystal.

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