American Mineralogist, Volume 82, pages 310–315, 1997

Cathodoluminescence of meteoritic and synthetic forsterite at 296 and 77 K using TEM

E.J. Benstock,[1] Peter R. Buseck,[1,2] and Ian M. Steele[3]

[1]Department of Geology, Arizona State University, Tempe, Arizona 85287-1404, U.S.A.
[2]Department of Chemistry and Biochemistry, Arizona State University, Tempe, Arizona 85287-1404, U.S.A.
[3]Department of Geophysical Sciences, University of Chicago, Chicago, Illinois 60637, U.S.A.

Abstract

Cathodoluminescence (CL) emission spectra of forsterite from the Allende (CV3) and Murchison (C2) meteorites and from Cr-doped and pure synthetic forsterite samples have been obtained at room (296 K) and liquid nitrogen (77 K) temperatures using a transmission electron microscope. At room temperature, three broad CL emissions centered near 420, 640, and 800 nm occur in the meteoritic forsterite, and one peak at 800 nm occurs in one Cr^{3+}-doped forsterite sample. Only the 420 nm peak is present in pure synthetic forsterite. Relative to room temperature, at liquid-nitrogen temperature there is a general increase in overall CL intensity, whereas a broad peak located between 700 and 800 nm changes to a series of sharp emissions centered near 700 nm and a narrower but still broad peak centered near 800 nm.

The portion of the broad peak near 700 nm at room temperature and equivalent sharp peaks at low temperature are assigned to Cr^{3+} in octahedral coordination, whereas the broad peak near 800 nm is attributed to Cr associated with structural defects. The peak at 640 nm is consistent with a similar peak in Mn^{2+}-doped forsterite. The peak at 420 nm results from an unknown structural effect that can be eliminated in synthetic forsterite by mechanical deformation. The variation of relative intensities at room temperature for the two broad peaks at 700 and 800 nm in meteoritic forsterite can be correlated with meteorite type and may reflect different processes in forsterite formation or subsequent processing.