

X-ray absorption characterization of Cr in forsterite within the MacAlpine Hills 88136 EL3 chondritic meteorite

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ABSTRACT

Chromium *K*-edge X-ray absorption spectra were collected to characterize Cr in forsterite (Mg_2SiO_4) as well as sulfides within the MAC 88136 EL3 chondrite to determine Cr valence and to see whether forsterite within this meteorite can be used as a Cr^{2+} -silicate standard. Spectra were measured on several areas within a nearly pure $100 \times 200 \mu\text{m}$ forsterite grain containing 0.13 wt% Cr. XANES findings indicate highly reduced Cr^{2+} species, with no clear evidence of Cr^{3+} or Cr^{6+} . EXAFS data indicate an average 2.02 Å Cr-O nearest-neighbor distance, consistent with Cr-O distances found in square-planar Cr^{2+}O_4 sites observed in synthetic crystalline silicates, and an average 2.69 Å Cr-Si second-nearest neighbor distance, consistent with Cr^{2+} substituting for Mg^{2+} in the forsterite M(1) site. Nearest-neighbor Debye-Waller factor and coordination number parameters indicate Cr^{2+} is likely entering forsterite in disordered sites that are possible intermediates between M(1) and square-planar Cr^{2+}O_4 configurations. Preliminary Cr XAS measurements on sulfides within this meteorite also indicate Cr^{2+} in CrS_6 octahedra.

Keywords: Cr^{2+} -silicate, meteorite, X-ray absorption spectroscopy