INTRODUCTION

Studies of minerals using polarized high energy X-rays from a synchrotron have long had the potential to provide information on directional bonding (Brown et al. 1988) but were hampered by the historically large beam sizes (>100 μm) relative to the size of available, optically homogeneous single mineral crystals. Furthermore, techniques for aligning single-crystal samples with respect to their crystallographic directions were not widely practiced. Thus, few researchers have had the opportunity to take full advantage of the polarization capability of most synchrotron facilities. In this letter, we show that application of the spindle stage to the synchrotron allows this potential to be fulfilled.

The technique is part of a larger, ongoing project by our group to characterize the extent of variation in Fe-XANES spectra of rock-forming minerals as a function of both composition and orientation (e.g., Delaney et al. 1996, 1998; Dyar et al. 1998a, 2001). Preliminary results from this work are presented in Gunter et al. (2002). The goal of this project was to develop a method to mount and orient small single crystals, 50–100 μm or less, so as to collect XANES spectra with the beam polarized along different directions within the same single crystal.

EXPERIMENTAL METHODS

Four mineral samples were chosen based on their optical classes: (1) almandine from Fort Wrangell, Alaska (Fe2+ garnet), which is optically isotropic; (2) buergerite from Mexquitic, San Luis Potosi, Mexico (Fe3+ tourmaline), and scapolite, which are optically uniaxial; and (3) Rockport fayalite (Fe2+ olivine), which is optically biaxial. The garnet, tourmaline, and olivine samples were previously studied by MDD and coworkers using Mössbauer spectroscopy, so they were already well characterized; their chemical analyses are reported in Dyar (1984), Dyar et al. (1998b), and Schaefer (1985), respectively. The scapolite sample was chosen for this study from M.E.G.'s personal collection; its composition is Na2.79 Ca1.04 K0.27 Fe0.01 Al1.87Si1.87O12(SO0.05Cl0.91) (normalized to Si + Al = 12 cations, with no OH assumed in the analysis; JSD microanalysis at Rutgers University using standard operating conditions, cf. Dyar et al. 2002). Selection of crystals was constrained by the need for