

Dehydroxylation, proton migration, and structural changes in heated talc: An infrared spectroscopic study

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ABSTRACT

The high-temperature dehydroxylation and structural change of talc, $\text{Mg}_3(\text{Si}_2\text{O}_5)_2(\text{OH})_2$, has been investigated in detail using infrared (IR) spectroscopy. The data (in the region of 20–12000 cm^{-1}) on quenched samples show that absorptions from structurally incorporated OH and OD, as well as NH_4 -like species, have similar temperature dependences in dehydroxylation. The OH species exhibit weak variation in frequency on heating, which is inconsistent with thermally induced weakening of O-H bonds. Dehydroxylation in talc is a complex process that involves proton migrations and formation of new OH species. Additional fundamental OH bands near 3665 and 3745 cm^{-1} became detectable near 900 °C. On further heating the former disappear near 1200 °C, whereas the latter became undetectable near 1350 °C. The occurrence of CO_2 is observed in samples quenched between 600 and 1250 °C. The phonon spectrum (20–1500 cm^{-1}) of the dehydroxylate (obtained by annealing the sample at 1000 °C) gives features significantly different from that of talc, indicating the loss of the original layer structure. The IR data imply that the talc dehydroxylate consists of disordered SiO_2 and enstatite (MgSiO_3). Although MgSiO_3 exists dominantly in the form of orthoenstatite, the characteristic bands of clinoenstatite phase are found to coexist in the samples treated at 1000 °C. The IR data from in situ measurements show that protons become mobile at temperatures below the dehydroxylation and an extra OH species near 3500 cm^{-1} develops on heating. This new species is not quenchable, and it decreases intensity on cooling and disappears at room temperature. The in situ results also indicate external carbon-related substances can diffuse into talc during dehydroxylation.

Keywords: Infrared spectroscopy, talc, dehydroxylation, OH, OD, NH_4 , CO_2 , enstatite