# Hydrous mineral formation from amorphous forsterite in the protosolar disk

D. YAMAMOTO[1*] AND S. TACHIBANA[1]

[1] Department of Natural History Sciences, Hokkaido University, Sapporo, Hokkaido 060-0810, Japan (*correspondence: daiki@ep.sci.hokudai.ac.jp)

Hydrous silicates formed by a reaction between anhydrous silicate and water vapor could be stable inside the snow line, where $H_2O$ condenses as ice. They could thus be a possible carrier of water to the rocky planet forming region in the dry inner solar system [1]. A kinetic study based on Simple Collision Theory (SCT) suggests that hydrous mineral formation between crystalline Mg-silicate and water vapor would be kinetically inhibited in the solar nebula [1]. Amorphous silicates, which are also present in protoplanetary disks, are thermodynamically unstable and may thus react with water vapor more effectively than crystalline silicates.

In this study, in order to explore the possibility of hydrous mineral formation from amorphous silicates, we performed reaction experiments between amorphous forsterite (synthesized by induced thermal plasma method) and water vapor at 323–373 K and water vapor pressure of ~0.1–1 bar.

The XRD and TEM analyses showed that amorphous forsterite transformed into serpentine and brucite. The time evolution of the serpentinization degree estimated from the development of 2.7 $\mu$m infrared feature and the change of 10 $\mu$m infrared feature can be fitted with the Johnson-Mehl-Avrami equation with Avrami exponent $n$ of ~1 and a geometrical contracting volume model, suggesting that the rate is controlled by the serpentinization reaction at the interface. Temperature dependences of the rate constants inferred from 2.7 and 10 $\mu$m features give the activation energies of ~16 kJ/mol and ~21 kJ/mol, respectively.

We evaluated the timescale of hydrous mineral formation from amorphous forsterite in protoplanetary disks based on the SCT using the obtained activation energies for hydration, and the timescale is compared with the dehydration timescales of serpentine [2] and brucite [3], and the crystallization timescale of amorphous forsterite [4]. The camparison of timescales indicates that amorphous forsterite could hydrate within the disk lifetime.

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