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Kinetic studies of the formation of arsenolite inclusion compound with hydrogen

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Hydrogen diffusion through porous and non-porous solid materials is crucial for fundamental studies on hydrogen migration within the Earth's crust and its deep reservoirs.[1] Investigations of hydrogen inclusion compounds are an integral part of the ongoing research into hydrogen- storage materials, which have potential applications in environmentally friendly transportation.[2]

This study presents the kinetics of hydrogen permeation in single crystals of arsenolite, the cubic polymorph of arsenic(III) oxide. The experiments were conducted under high pressure using Fourier-transform infrared spectroscopy. Two single crystals of arsenolite were placed in diamond anvil cells and subjected to pressures of 1.37(5) GPa and 1.47(5) GPa for 11 hours and 1 hour, respectively. Hydrogen was used both as a pressure-transmitting medium and as a reactant forming the inclusion compound. Arsenolite was completely transformed into $As_4O_6 \cdot 2H_2$, with a linear growth rate of the inclusion compound, indicating that the rate-limiting step in the transformation is the reaction at phase boundaries rather than diffusion. Notably, at 1.37(5) GPa, two distinct domains of linear growth with different rates were observed.

Furthermore, a method for growing thin plates of As_4O_6 single crystals via spatial confinement will be presented. The use of micro-sized, thin-layered platelets (as shown in Figure 1) has proven to be an effective approach for studying diffusion kinetics in crystals. Measurements conducted at the SMIS infrared spectromicroscopy beamline at the SOLEIL Synchrotron confirm the effectiveness of this novel methodology.[3]

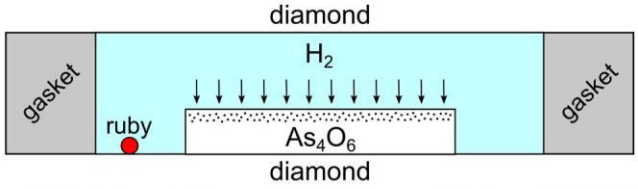

Figure 1. Schematic drawing of the experimental setup.

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