

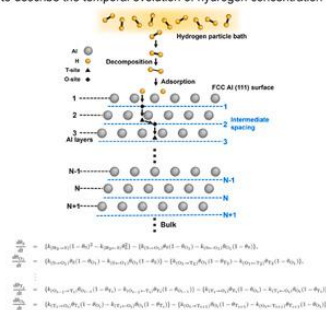
Quantitative analysis of hydrogen absorption in pure aluminum: Theoretical and experimental approaches

Akio Ishii

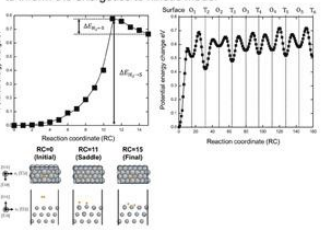
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Theoretical

Kinetic model
to describe the temporal evolution of hydrogen concentration

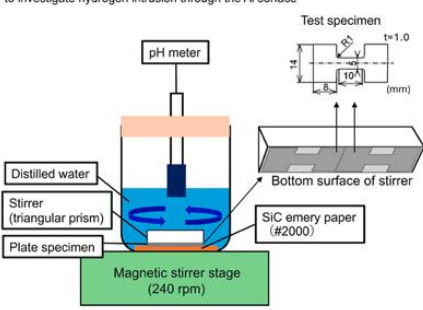


Density functional theory calculation
to inform the energetics to kinetic model

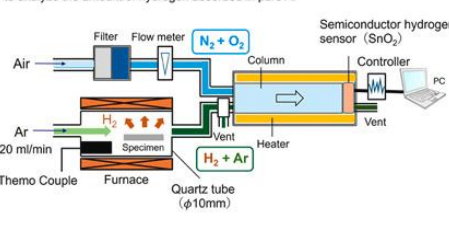


Experimental

Surface friction in water (FW)
to investigate hydrogen intrusion through the Al surface

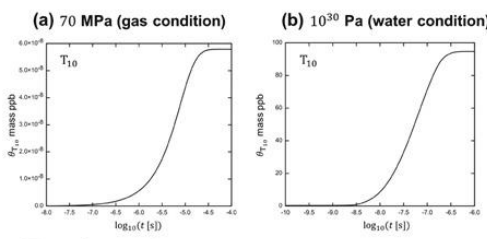


Thermal desorption analysis
to analyze the amount of hydrogen absorbed in pure Al

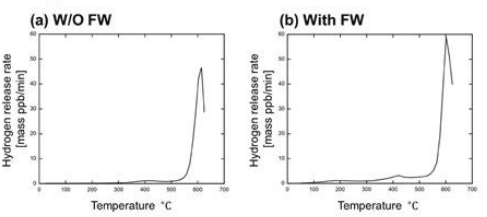


Quantitative analyses of hydrogen absorption in pure Al

Theoretical



Experimental



ABSTRACT

In this study, we quantitatively investigated the hydrogen absorption in pure Al under surface exposure to high-pressure hydrogen gas or water from both theoretical and experimental perspectives. From a theoretical perspective, we implemented a non-empirical multiscale analysis of the temporal evolution of hydrogen concentration in face-centered cubic Al under exposure of the (111) surface to high-pressure hydrogen gas or water using density functional theory and a recently proposed simple kinetic model. From an experimental perspective, we developed a method to introduce hydrogen onto the Al surface without an oxide layer in the presence of water by utilizing surface friction in water (FW). After the FW process, the amount of hydrogen absorbed was measured via thermal desorption analysis. The theoretical and experimental results agreed well, and the estimated hydrogen concentration in the bulk under water conditions was approximately 100 mass ppb, although we theoretically confirmed that the absorption of hydrogen in bulk Al under high-pressure hydrogen gas conditions (70 MPa) was negligible; the concentration in the bulk was only 10–6 mass ppb. We also performed a tensile test on a hydrogen-charged pure Al sample to investigate the effect of hydrogen on the tensile properties and confirmed that 100 mass ppb order hydrogen charging in Al significantly reduces the tensile strength of Al.

Purpose

Quantitative analysis of hydrogen absorption in pure aluminum

Computer: SQUID