# KIMURA LAB.

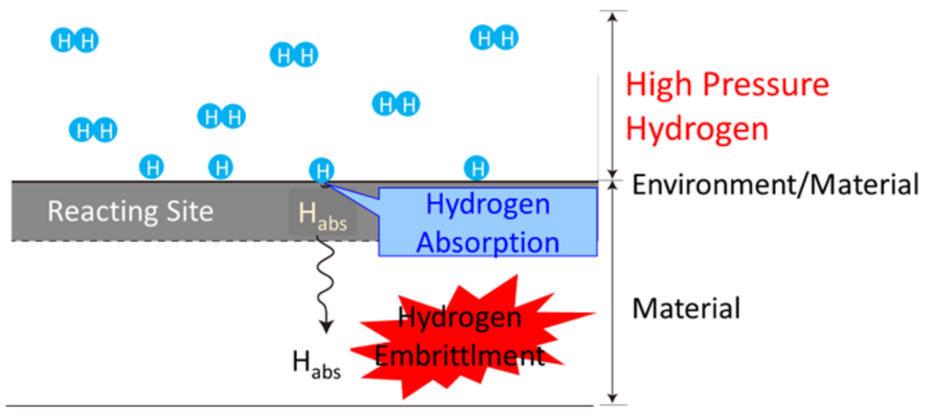
## Evaluation of Metallic Materials in Hydrogen

Department of Fundamental Engineering

Material for Hydrogen Embrittlement Resistance

## Test Method to Establish Hydrogen Compatibility of Materials in Hydrogen Gas Environments

Hydrogen energy is attracting attention for the realization of a low-carbon society. In addition, the expansion of the transportation and storage of liquid hydrogen for future large-scale hydrogen use is being considered. On the other hand, when metallic materials are exposed to hydrogen environments, hydrogen atoms enter the material, and cause hydrogen embrittlement. Therefore, hydrogen compatible test methods have been required to select suitable materials in many fields, including hydrogen stations and large liquid hydrogen storage tanks etc.. We have conducted to achieve global harmonization of hydrogen compatibility testing in hydrogen environment.



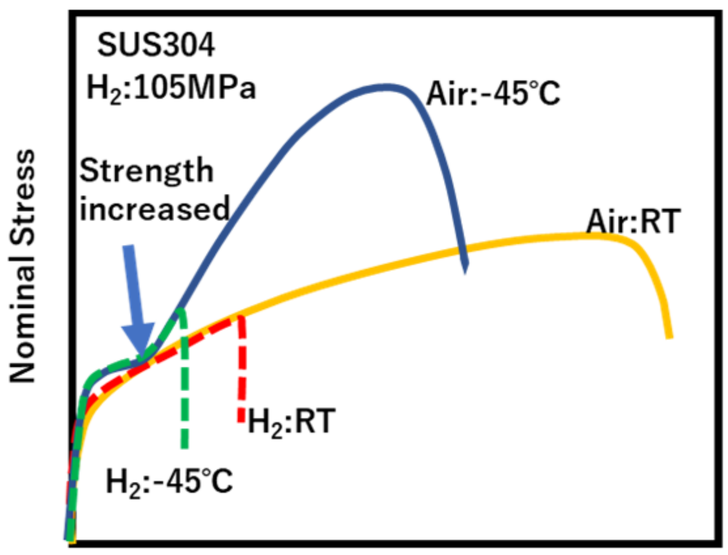

**Mechanism of hydrogen embrittlement in hydrogen gaseous environments**

### Mechanism of Hydrogen embrittlement

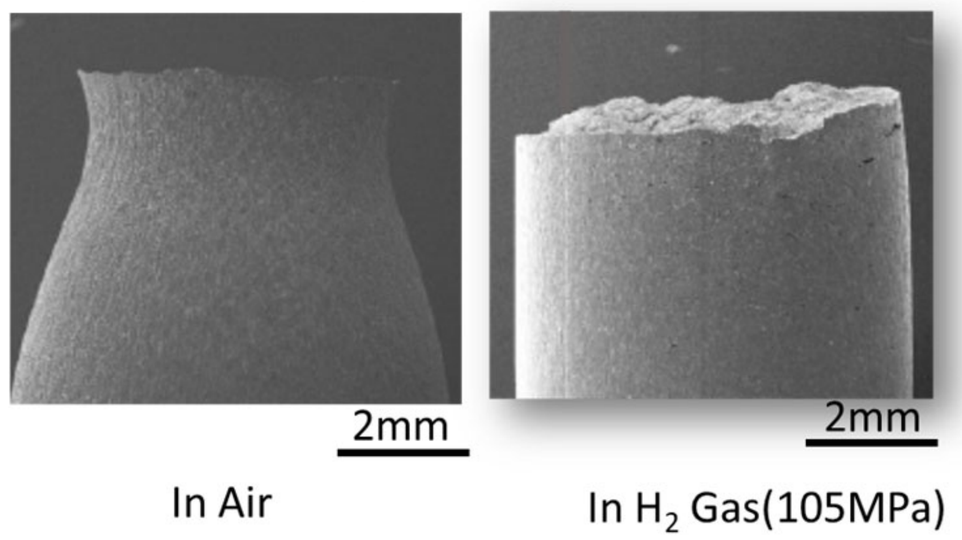
①Hydrogen atoms adsorb on the material surface
②Hydrogen atoms penetrate the interface of material
③Hydrogen atoms diffuse in materials

### Hydrogen Compatibility Testing

The hydrogen compatibility of metallic materials used in high pressure hydrogen environments have been evaluated by following testing methods.
①Slow Strain Rate Technique (SSRT) Testing
②Fatigue Life Testing
③Fatigue Crack Growth Rate Testing




**SSRT test results in $H_2$ and air environment** (Ductility deterioration was observed in $H_2$ environments)




**Hydrogen crack propagation mechanism of γ-based stainless steel** (Martensite transformation by local strain is involved in hydrogen diffusion and embrittlement)

**Appearance of SSRT tested specimens**