Hydrogen-compatible SUS304: combination of nitrogen and grain size refinement

Arnaud MACADRE*, Ryo OKAMOTO**, Koki YAMAMOTO**, Taiga ONO**

*Graduate School of Sciences and Technology for Innovation, Division of Mechanical Engineering

** Graduate School of Sciences and Technology for Innovation, Division of Mechanical Engineering, graduated

With worsening climate change, and the increasing possibility of limited access to fossil fuels, renewable energies are more than ever necessary. Among them hydrogen, although it remains a challenge, as it causes hydrogen embrittlement, i.e. the decrease of mechanical properties of metallic materials. Austenitic stainless steels are typically less affected by hydrogen, owing to their low diffusivity and high solubility of hydrogen, preventing hydrogen from reaching critical levels within the material. However, not all austenitic steels are equal. Stable austenitic steels remain austenitic through deformation, and with that keep their relative resistance to hydrogen. Metastable austenitic steels undergo phase transformation, and the resulting martensite is very sensitive to hydrogen embrittlement. Unfortunately, the stability is typically dependent on the nickel content, which means increased costs.

Here, a metastable austenitic stainless steel, SUS304, subject to hydrogen embrittlement, was improved by the combination of nitrogen addition and grain size refinement. Nitrogen improved both strength and austenite stability, grain size refinement further improved the mechanical properties. This resulted in a steel that was not embrittled to hydrogen, opening avenues for hydrogen-compatible parts made of SUS304.