Name	Job Title	Area of Expertise
OHGAI Takeshi	Professor	Metallurgy

1. Main Research Topics

The physical properties of metallic materials are determined by their microstructure, including grain size, lattice defect density, and the dispersion state of precipitates. The constituent phases of this microstructure change in such a way as to reduce Gibbs free energy, ultimately settling into a thermodynamically stable phase. This thermodynamically stable phase is uniquely determined by the alloy composition and temperature, and its database is summarized in a phase diagram. While the properties of these thermodynamically stable phases have already been elucidated, the properties of non-equilibrium phases during phase transformations, where atomic diffusion is insufficient, remain largely unknown and hold the potential to exhibit exceptionally superior properties. One method for producing these non-equilibrium phases is the solid solution preparation method using rapid cooling from the liquid or gas phase, but this requires high-temperature and high-vacuum conditions. On the other hand, the aqueous solution electrolysis method allows for the reduction of hydrated metal ions at room temperature and pressure, enabling the easy production of thermodynamically non-equilibrium phases. Below, I introduce research themes related to the production and property evaluation of non-equilibrium phases using the aqueous solution electrolysis method.

① **Electrochemical Synthesis of Nanochannel Structured Metal Oxide Films**

I have developed anodized aluminum oxide thick filters with numerous nanochannels which can be applied to a template material for developing a novel functional device.

② **Development of Metallic Multilayered Nanowires Array with CPP-GMR Response**

Using a pulsed current electrodeposition technique from an aqueous solution, I have fabricated a multi-layered nanowire array with alternating layers of ferromagnetic and antiferromagnetic metals. The multi-layered nanowire exhibited a giant magnetoresistance effect with applying current in perpendicular to the layered interfaces (see Fig. 1).

③ **Characterization of Iron-group Metal Based Amorphous Alloy Films Electrodeposited from Aqueous Solutions**

I have synthesized iron-group metal based amorphous alloy thick films by applying an induced co-deposition technique from an aqueous solution. The amorphous alloy thick films exhibited excellent mechanical performance with high-strength, high-corrosion-resistant, and catalytic properties.

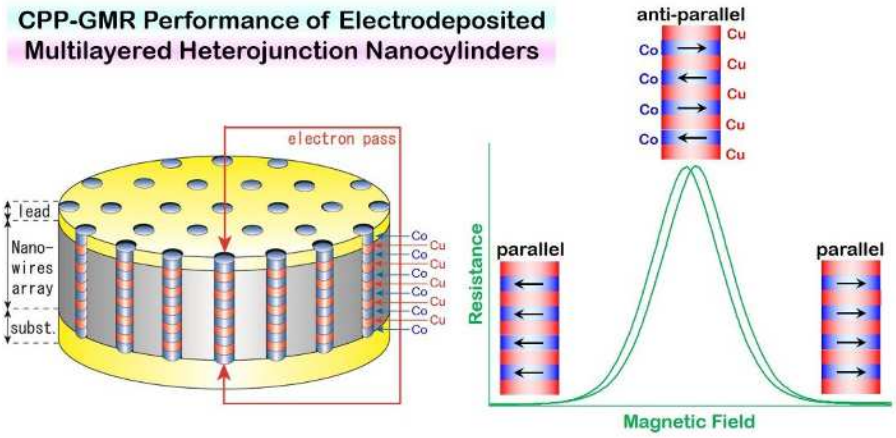

Fig.1 Electrochemical synthesis and characterization of metallic multilayered nanowires array with CPP-GMR (current perpendicular to plane giant magnetoresistance) response.

2. Keywords

Metallic materials, Metallic nanomaterials, Electrodeposition, Anodization, Metal surface finishing, High strength alloys, Magnetoresistance, Corrosion-resistance alloys

3. Remarks and Websites

I am currently developing new functional metallic materials with non-equilibrium phases utilizing metal surface treatment technology, mainly using an electrodeposition technique from aqueous solution.

researchmap: https://researchmap.jp/read0118950

Laboratory: https://www.cms.nagasaki-u.ac.jp/lab/soshiki/index.html