

## Preparation and Oxygen Reduction Reaction Electrocatalysis of Platinum-Gadolinium-Rhodium Alloy Nanoparticles

(<sup>1</sup>Dept. Chem., Grad. Sch. Sci., Nagoya Univ., <sup>2</sup>RCMS, Nagoya Univ.)

○Takumi Moriyama,<sup>1</sup> Satoshi Muratsugu,<sup>1</sup> Mizuki Tada<sup>1,2</sup>

**Keywords:** Platinum; Gadolinium; Rhodium; Alloy Nanoparticle; Electrocatalyst

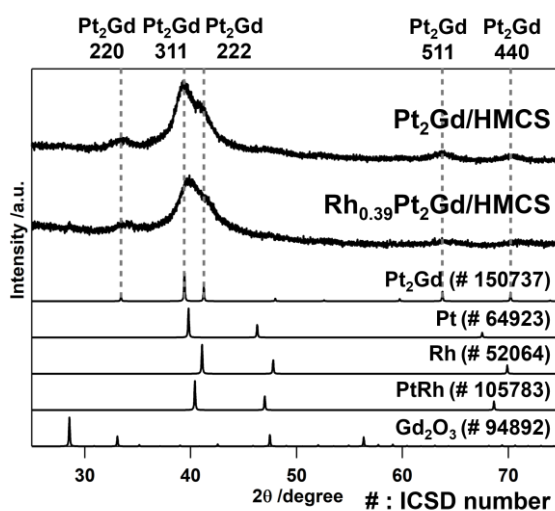
Platinum (Pt) - gadolinium (Gd) alloys are expected to be efficient oxygen reduction reaction (ORR) electrocatalysts. We succeeded in preparing HMCS-supported Pt<sub>2</sub>Gd alloy nanoparticle electrocatalysts (Pt<sub>2</sub>Gd/HMCS) with narrow size distribution from Pt and Gd organometallic complexes, and the prepared catalyst was found to exhibit high ORR activity and durability compared with Pt catalyst on HMCS.<sup>1</sup> Since the incorporation of the third metal species to Pt-transition metal alloy nanoparticles was reported to be one of the effective modification methods to improve electrocatalytic property of Pt catalysts,<sup>2</sup> we investigated the preparation of Pt-Gd-Rh alloy nanoparticles as more efficient ORR electrocatalysts than Pt-Gd alloy nanoparticles by incorporating rhodium (Rh) as the third metal species.

Pt, Gd, and Rh organometallic complexes, (1,5-cyclooctadiene)dimethylplatinum(II), tris(tetramethylcyclopentadienyl)gadolinium(III), and chloro(1,5-cyclooctadiene)rhodium(I) dimer were co-grafted on hollow mesoporous carbon sphere (HMCS), and it was reduced under oxygen- and water-prohibited conditions, similar to the preparation of Pt<sub>2</sub>Gd/HMCS. The powder XRD patterns of prepared sample (Rh<sub>0.39</sub>Pt<sub>2</sub>Gd/HMCS) showed only the peaks attributed to Pt<sub>2</sub>Gd alloy shifted toward the high-angle side (Figure 1), suggesting the formation of Rh-doped Pt<sub>2</sub>Gd alloy nanoparticles. The formation of Pt-Gd-Rh alloys was also supported by HAADF-STEM-EDS, and Pt L<sub>III</sub>-edge and Rh K-edge XAFS. The average particle size of the Pt-Gd-Rh alloy nanoparticles on Rh<sub>0.39</sub>Pt<sub>2</sub>Gd/HMCS (5.7 nm) was found to be almost similar to the Pt<sub>2</sub>Gd alloy nanoparticles on Pt<sub>2</sub>Gd/HMCS (5.9 nm)<sup>1</sup>.

ORR properties of Rh<sub>0.39</sub>Pt<sub>2</sub>Gd/HMCS were also evaluated by RDE procedures. Rh<sub>0.39</sub>Pt<sub>2</sub>Gd/HMCS showed higher ORR initial activity than Pt<sub>2</sub>Gd/HMCS, suggesting the positive effect of Rh. The ORR durability of Rh<sub>0.39</sub>Pt<sub>2</sub>Gd/HMCS will also be reported.

(1) Moriyama, T. *et al. J. Am. Chem. Soc.* **2025**, *147*, 1262-1270.

(2) Li, X. *et al. Angew. Chem. Int. Ed.* **2024**, *63*, e202400549.



**Figure 1.** Powder XRD of Pt<sub>2</sub>Gd/HMCS and Rh-Pt<sub>2</sub>Gd/HMCS, and references.