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Observation of MOF-Derived Carbon Cage-Encapsulated Ru Metal Nanoparticles

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1. Background

Metal nanoparticle (MNPs) catalysts have very recently emerged as a new research frontier in catalysis. MNPs encapsulated in carbon cages demonstrated to present better catalytic behaviors, possibly owing to the change of coordination environment of metal atoms. In this report, we attempted to prepare carbon cage-encapsulated MNPs by pyrolysis of the metal-organic frameworks with loading of corresponding metal species precursors.

2. Experiments

X-ray absorption fine structure (XAFS) analyses of the carbon cage-encapsulated RuNPs (Ru@CC) were performed at Aichi Synchrotron Radiation Center (BL11S2). Each powder sample pressed as pallets were analyzed.

3. Results and Discussion

Currently, element-selective XAFS, including X-ray absorption near-edge spectroscopy (XANES) and extended X-ray absorption fine structure (EXAFS) spectroscopy, has been considered as a necessary characterization for the MOF-derived catalysts, which can demonstrate coordination environment of metal atoms via verifying the coordination configurations of metal-metal and metal-oxygen in the spectra.[1] So, XAFS analyses were performed to investigate the local environment of Ru atoms in Ru@CC. As shown in Figure 1, the obtained Ru K-edge XAFS spectra showed that our samples exhibited distinctly different profiles from that of corresponding metal foil (blue lines). The coordination configurations were then determined by the Fourier transformed k^3-weighted $\chi(k)$-function of the corresponding EXAFS spectra in R space. We have confirmed the formation of Ru-O coordination in Ru@CC.

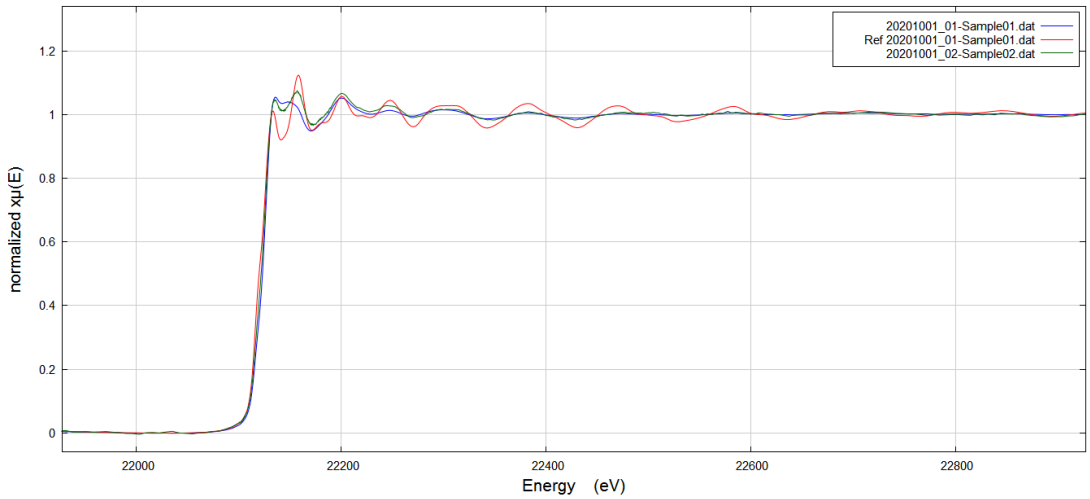

Figure 1. Ru K-edge XAFS spectra.

4. References

1. Xu, Q. et al. Solid-solution alloy nanoclusters of the immiscible gold-rhodium system achieved by a solid ligand-assisted approach for highly efficient catalysis. *Nano Research* (2020) 13, 105-111.