Name	Job Title	Area of Expertise
NAKAGOE Osamu	Assistant Professor	Surface Chemistry, Catalytic Chemistry

1. Main Research Topics

① **Preparation of Cu nanoparticle loaded TiO_2 photocatalyst and improving photocatalytic activity for water splitting**

Photocatalytic hydrogen formation from water splitting reaction is the one of the most attractive topics for sustainable energy supply because of zero carbon emission process. However, the hydrogen formation has not been applied in industrial process due to its slow rate of the photocatalytic water splitting reaction. Especially, TiO_2, which is one of the most popular photocatalyst is inefficient and impractical for commercial application to photocatalytic hydrogen formation without modification of cocatalyst such as noble metal, although it is abundant, cost effective, and clean for environment on account of lacking of ionic leaching with self-oxidation. Noble metal, such as Pt, Au, and Rh, loading to TiO_2 can improve photocatalytic performance. Instead of Pt, Cu is good candidate for cocatalyst of TiO_2 because it has a pretty low cost compared to Pt, less than 1/3000 and about half of photocatalytic performance. Moreover, tuning size, oxidation state, and shape of Cu nanoparticle on TiO_2 improve photocatalytic performance owing to adjustment of its electronic properties, such as energy level, work function etc.

In this study, size tunable Cu nanoparticles were prepared by thermal reduction process of Cu precursor with amino-2-propanol (AmIP) as surfactant. The ratio between AmIP and Cu^{2+} determined size of nanoparticle. Cu loaded TiO_2 catalysts (Cu/TiO_2) were obtained with impregnation method. As the result of photocatalytic water splitting reaction, as prepared catalysts had 1/3 the rate of hydrogen formation of Pt. It is expected that optimization of size and loading amount of Cu lead to enhance the rate of hydrogen formation.

② **Synthesis of CaO fine particle and application in Biodiesel fuel catalyst**

Biodiesel fuel (BDF), a substance defined as fatty acid methyl ester, is already required in the EU as a 10% or greater component of fuel for public transportation. BDF is produced by transesterification of fats and oils with methanol, using a homogeneous sodium methoxide as a catalyst. While sodium methoxide is highly active, there are disadvantages for washing BDF with water, including the removal of alkaline wastewater and the production of soap as a side reaction. In contrast, the use of solid base catalysts omits the water washing process. However, calcium oxide, a commonly used solid base, has a large particle size and low specific surface area, resulting in a significantly low reaction rate than homogeneous solution catalysts. Therefore, we synthesized 50-nm calcium oxide particles, approximately one-twentieth the size of those produced by conventional alkaline precipitation methods, in a polyacrylic acid solution. In this synthesis, a calcium carbonate precursor was formed within a random coil of size-controlled polyacrylic acid, and nanoparticles were then obtained by thermal decomposition in vacuum. So far, polyacrylic acid used as a template has been removed by oxidation in air, but by using accelerated oxidation removal using a combination of ozone and hydrogen peroxide, we aim to suppress particle growth and further improve performance.

2. Keywords

Heterogeneous catalysis, nanoparticle, nanocomposite, photocatalyst, solid state acid base catalyst

3. Remarks and Websites

I can prepare metallic and oxide nanoparticle, nanocomposite, and porous material it for heterogeneous catalyst and adsorbent since my research subject is surface chemistry and catalytic chemistry. Actually, I have collaborated photocatalytic application in water treatment with a private company.

researchmap:
Laboratory: https://www.cms.nagasaki-u.ac.jp/lab/nanokaimen/