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Rhenium and rhenium-copper nanoparticles: evaluation of the catalytic activity for the decomposition of ammonium perchlorate

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The development of solid propellants for rockets is of great importance in the aerospace industry. They offer numerous advantages compared to other types of fuels. Their long-term stability, ease of storage and handling, and the possibility of instant ignition make them a highly reliable and safe option for space missions and rocket launches [1].

In this study, was investigated the catalytic efficacy of rhenium nanoparticles stabilized with PAMAM dendrimers (ReNP@PAMAM) and rhenium-copper nanoparticles (ReCuNP@PAMAM) [2] for the decomposition of ammonium perchlorate (AP) in composite solid propellants. AP is identified as a key component in energy generation in solid propellants; therefore, efficient decomposition is essential. The hypothesis is that incorporating of catalytic nanocomposites can improve the efficiency of this process.

Rhenium is primarily obtained from molybdenite (MoS_2), and Chile holds the world's largest rhenium reserves. However, there is a lack of studies on rhenium catalysts for AP decomposition, as well as the search for new and more effective systems to enhance energy release.

The nanocomposites were prepared by reducing ammonium perrhenate (NH_4ReO_4) in the presence of PAMAM dendrimers. Techniques such as transmission electron microscopy (TEM) and X-ray diffraction (XRD) [3] were used to characterize the morphology and structure of the nanocomposites. In addition, density functional theory (DFT) calculations were performed to study the stabilization of metal ions by dendrimers. Differential scanning calorimetry (DSC) and thermogravimetry (TGA) analyses were also conducted to evaluate the catalytic properties of the nanocomposites in the decomposition of ammonium perchlorate.

On one hand, the results revealed that ReNP@PAMAM exhibited predominantly spherical morphology, with an average size of approximately 1 nm. On the other hand, ReCuNP@PAMAM exhibited cuboctahedral shapes and an average size of around 5 nm.

Regarding catalytic activity, it was found that both rhenium and rhenium-copper nanoparticles showed higher efficiency in AP decomposition compared to pure AP [4]. Furthermore, ReCuNP@PAMAM exhibited higher catalytic activity compared to ReNP@PAMAM alone. In conclusion, the study demonstrated that rhenium and rhenium-copper nanoparticles hold promise as catalysts for AP decomposition in composite solid propellants. These findings suggest that these nanoparticles could improve efficiency and energy release in propulsion systems.

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