ホウ化水素研究センター
Hydrogen Boride Research Center

Title: Synergistic multi-catalyst strategies for kinetic enhancement of hydrogen storage in Mg-based nanocomposites for vehicular applications

Abstract:

Rapid population growth and technological advances have intensified energy demand, largely met by fossil fuels that contribute to pollution and health risks. Hydrogen, with its high energy density (140 MJ/kg) and zero emissions, is a sustainable alternative, and magnesium hydride (MgH_2) offers promise for automotive storage due to its high reversible capacity, though challenges such as poor sorption kinetics under PEM fuel cell conditions and oxidation susceptibility limit its use. A key obstacle is the "incubation" period, where oxide films delay hydrogen uptake and release, requiring multiple activation cycles. Our studies using dark-field TEM, XRD, Raman, and electron density maps from XRD have traced the reason as hydrogen diffusion from the bulk to the surface of Mg particles.

Eliminating incubation enables immediate hydrogenation, and catalysts like reduced graphene oxide (rGO) significantly enhance performance by forming persistent Mg–C interactions that alter carbon hybridization, enable reversible electron transfer, weaken Mg–H bonds, and accelerate release, as confirmed by XRD, Raman, XPS, and FTIR. Further improvements arise from dual catalysts: Mg–Ni–rGO nanocomposites show negligible incubation and lower release onset temperatures (350 → 275 °C) due to synergistic Ni–C interactions and residual metallic Ni, while Mg–B–rGO systems exploit B as a charge donor to expand the Mg unit cell and reduce incubation, collectively demonstrating how multi-catalyst strategies advance Mg-based hydrogen storage toward practical vehicular applications.

Bio-sketch:

Sankara Sarma V. Tatiparti is a professor in the Dept. of Energy Sci. & Engg. at Indian Institute of Technology Bombay (IIT Bombay) INDIA. He obtained his PhD from Dept. of Materials Sci. & Engg. at University of Florida in 2008. Eventually, he conducted his postdoctoral research at Dept. of Inorganic Chemistry, Utrecht University, The Netherlands in 2010. Following this, he returned to India and worked as Research Scientist at India Science Lab at General Motors, Bangalore INDIA in 2012, prior to taking up faculty position at IIT Bombay. He authored ~60 research articles in reputed international journals with over 1150 citations and h-index of 19. He graduated 10 PhD students and mentored 6 Postdocs. His research interests are in developing Materials for hydrogen storage for transport applications, Hybrid electrochemical energy storage devices and Electrodepositon of Al-alloys.