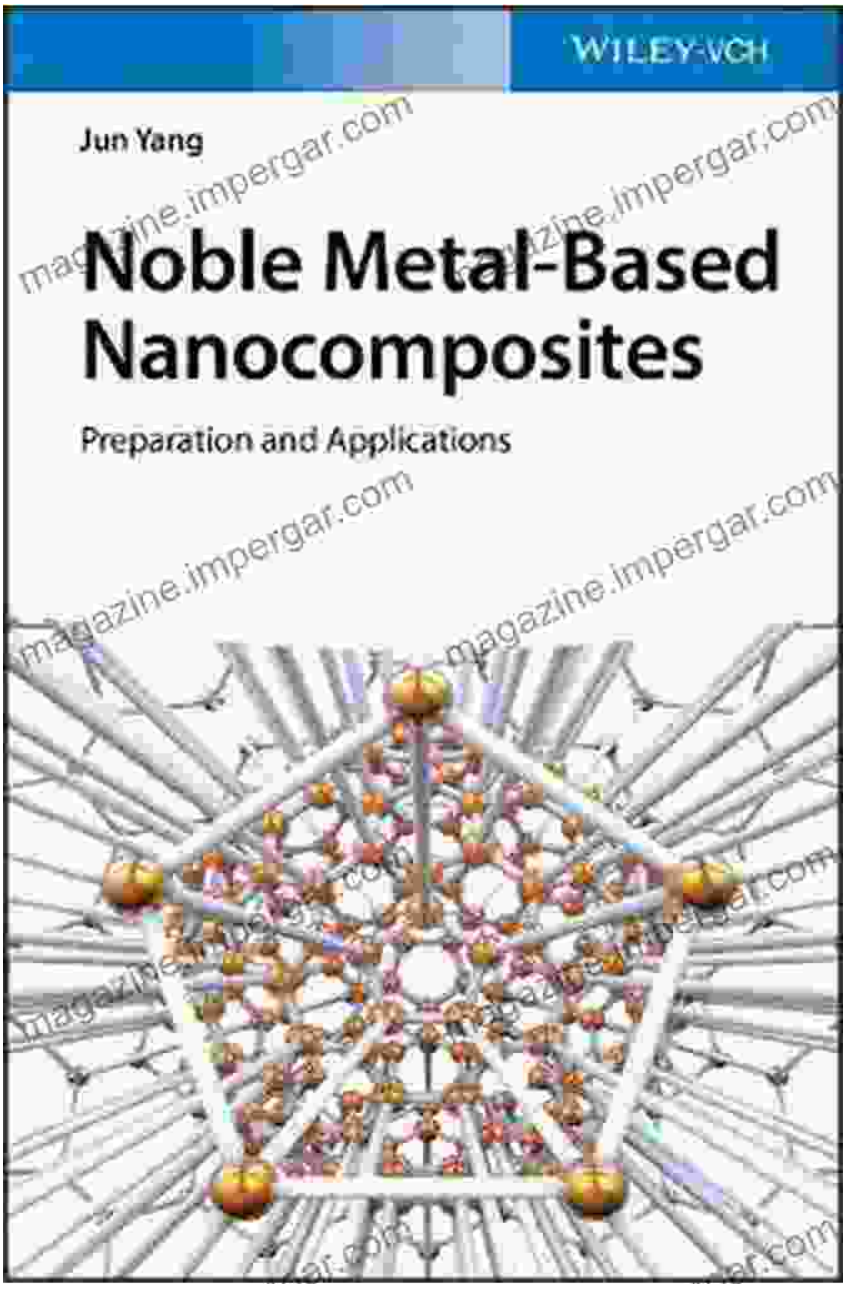
Noble Metal Based Nanocomposites: Preparation And Applications



Noble Metal-Based Nanocomposites: Preparation and Applications by Jun Yang

4.4 out of 5

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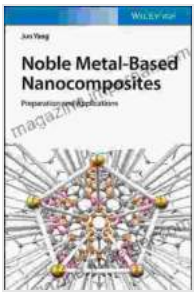

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Nanocomposites, a unique class of materials, combine the properties of individual components to create materials with enhanced or entirely new characteristics. Noble metal based nanocomposites, in particular, have attracted significant attention due to their remarkable properties and wide-ranging applications. This comprehensive article delves into the preparation and applications of noble metal based nanocomposites, providing an in-depth understanding of their synthesis techniques and the diverse fields they impact.

Preparation Methods

The preparation of noble metal based nanocomposites involves precise control over the size, shape, and dispersion of the noble metal nanoparticles within the host matrix. Various methods have been developed to achieve this, including:

- **Chemical Reduction:** This method involves the reduction of noble metal ions in the presence of a reducing agent, such as sodium borohydride or sodium citrate, leading to the formation of metal nanoparticles.

- **Sonochemical Synthesis:** Utilizing high-intensity ultrasound, this method generates cavitation bubbles that collapse, creating localized high temperatures and pressures, promoting the formation and growth of metal nanoparticles.
- **Electrochemical Deposition:** This technique involves the electrodeposition of noble metal ions onto a substrate, allowing for precise control over the thickness and morphology of the nanocomposite.
- **Template-Assisted Synthesis:** This approach utilizes a template, such as a porous membrane or a self-assembled monolayer, to guide the growth of the metal nanoparticles, resulting in well-Free Downloaded nanocomposites.

Catalytic Applications

Noble metal based nanocomposites have emerged as highly efficient catalysts, finding applications in various chemical reactions. Their unique properties, such as high surface area, tunable particle size, and synergistic effects between the noble metal and the host matrix, contribute to their exceptional catalytic activity.

- **Hydrogen Production:** Nanocomposites containing noble metals, such as platinum or palladium, have shown promising results in the catalytic generation of hydrogen from water splitting, a crucial process for clean energy production.
- **Fuel Cells:** Noble metal based nanocomposites are widely used as electrocatalysts in fuel cells, facilitating the conversion of chemical energy into electrical energy.

- **Organic Synthesis:** These nanocomposites exhibit high selectivity and activity in organic reactions, including hydrogenation, oxidation, and coupling reactions.

Optical Properties

The incorporation of noble metal nanoparticles into a host matrix can significantly alter the optical properties of the nanocomposite. These materials exhibit unique light-matter interactions, leading to applications in optoelectronics and photonics.

- **Surface Plasmon Resonance:** Noble metal nanoparticles exhibit localized surface plasmon resonance (LSPR),which is the collective oscillation of free electrons in response to incident light. This phenomenon enables applications in sensing, imaging, and nonlinear optics.
- **Enhanced Fluorescence:** The presence of noble metal nanoparticles can enhance the fluorescence of nearby molecules, improving the sensitivity of biosensors and enabling super-resolution imaging.
- **Tunable Optical Properties:** By controlling the size, shape, and composition of the noble metal nanoparticles, the optical properties of the nanocomposites can be precisely tuned for specific applications.

Energy Storage

Noble metal based nanocomposites have shown great potential in energy storage applications due to their high surface area, excellent electrical conductivity, and electrochemical stability.

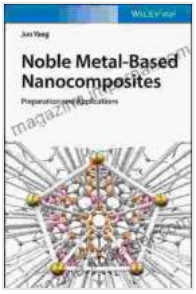
- **Supercapacitors:** These nanocomposites exhibit high capacitance and rate capability, making them promising materials for high-performance supercapacitors.
- **Batteries:** Noble metal based nanocomposites are used as electrode materials in batteries, improving their capacity, cycle life, and power density.
- **Fuel Cells:** As mentioned earlier, noble metal based nanocomposites are crucial components of fuel cells, facilitating the efficient conversion of chemical energy to electrical energy.

Biomedical Applications

The unique properties of noble metal based nanocomposites have opened up new avenues for biomedical applications. Their biocompatibility, coupled with their tunable properties, makes them suitable for a wide range of medical uses.

- **Drug Delivery:** Noble metal based nanocomposites can be used as drug carriers, delivering therapeutic agents to specific target sites with enhanced efficacy and reduced side effects.
- **Bioimaging:** These nanocomposites are employed as contrast agents in imaging techniques, such as computed tomography (CT) and magnetic resonance imaging (MRI),enhancing the visualization of biological structures.
- **Biosensors:** The optical and electrical properties of noble metal based nanocomposites make them ideal for biosensors, enabling the detection of biomarkers and pathogens with high sensitivity and specificity.

Noble metal based nanocomposites represent a remarkable class of materials with exceptional properties and a wide range of applications. Their unique combination of catalytic activity, optical properties, energy storage capabilities, and biomedical potential has positioned them as key materials for advancing various fields. Ongoing research and development continue to unveil new possibilities for these nanocomposites, promising even more transformative applications in the future.



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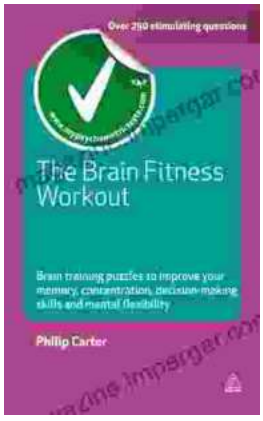

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