Electron-Irradiated Carbon Nanomaterials for Solid-State Hydrogen Storage

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Graphene has been proposed as a hydrogen storage medium capable of alleviating the concerns that come with other forms of hydrogen storage. However, current studies rely on pristine graphene flakes that are costly and impractical for large-scale implementation in the industrial and energy processes for which hydrogen is becoming essential. As such, this work investigates whether carbon nanopowder graphene oxide (GO) and reduced graphene oxide (rGO) can undergo electron-irradiation induced chemical modification in line with hydrogenation. GO and rGO films were deposited onto SiO_2 substrates and subjected to low - energy electron irradiation, with either X-ray photoelectron spectroscopy (XPS) or Raman spectroscopy used to analyze chemical bond structure before and after treatment. Deconvolution of Raman spectra shows that irradiation causes a decrease in the D'-Gapp parameter, signifying reduction and loss of functional groups, but also a shift towards sp^3 defect character, suggesting a new adsorbate that is plausibly hydrogen. XPS peak analysis corroborates these findings by showing a decrease in C-O peak intensity but increase in C-H peak intensity, again plausibly suggesting the addition of hydrogen adsorbates. Together, these results provide evidence that low-energy electron irradiation can chemically modify carbon nanopowders in a manner that is consistent with chemisorption-based hydrogen storage, with future work extending characterization methods to alternate materials to further reveal irradiation - induced bonding mechanisms. By advancing hydrogen storage in low-cost, scalable materials, this work proves promising towards the development of safer and more practical hydrogen systems for both energy and other industrial applications.

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