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Hydrochar and Its Composites for Highly Efficient Pollutant Removal

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Abstract. Research on 2D nanomaterials with unique structural and electronic features has shown rising to a remarkable height and will keep on staying as a significant topic in materials science. In this regard, there are intensive interests to introduce 2D g-C_3N_4 materials and exploration of their unique tunable and controllable properties in a predictable manner. These 2D materials are achieved through various synthetic routes and the crucial role of these 2D materials is having a broad range of applications, including CO_2 photoreduction, the degradation of refractory pollutants, and the production of renewable and sustainable hydrogen fuel. Graphitic carbon nitride (g-C_3N_4) has been regarded as a promising metal-free photocatalyst for addressing the energy crisis and environmental issues because of its fascinating electronic band structures, photochemical stability, and efficient light harvesting with suitable bandgap energy of 2.7 eV. However, its photocatalytic effectiveness is constrained by low surface area and low-charge carrier mobility. Its distinct band structure provides a promising technique to enhance the charge separation, improve the surface area, and enhance light absorption when coupled with a semiconductor having a wide bandgap. Metal oxides, sulfides, and ferrites have been categorized and described as the three main systems of g-C_3N_4-based nanocomposites. The future challenges and prospective solutions that may direct the development of 2D advanced nanomaterials based on g-C_3N_4 and their photocatalysis related applications overviewed based on our recent results.

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Hydrochar and Its Composites for Highly Efficient Pollutant Removal

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Abstract. Water pollution caused by industrial effluents without prior purification treatment represents one of the serious environmental concerns in contemporary times. Lately, due to its surface characteristics, pronounced chemical reactivity, and efficient regeneration ability, hydrochar obtained by hydrothermal carbonization of waste biomass has been explored as sustainable adsorbents for the removal of different pollutants. Besides, potential disadvantages of this material,

such as low specific surface area and porosity, are easily overcome by surface modifications and composites synthesis. Previous reported studies have shown that chemical methods that include hydrogen peroxide or alkalis treatment, and incorporation of metals onto hydrochar surface can significantly improve its adsorption performances. Within this study, the potential application of hydrochars from different precursors and its composites as efficient sorbents of organic dyes and heavy metals from aqueous solutions will be discussed. Special attention will be directed towards structural changes caused by modification, achieved adsorption capacities and potential adsorption mechanisms. In general, the valorisation of hydrochar as a polluter sorbent solves the problems of sustainable and efficient material for purification and disposal of waste with permanent consequences to the environment.

Keywords: hydrothermal carbonization, novel carbon adsorbent materials, hydrochar composites, waste minimization, wastewater purification

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Study on Silica-based Rubber Composites Using Improved Geothermal Silica

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Abstract. This study aims to investigate the potential of upgrading geothermal waste (GW) as an effective reinforcing filler for rubber composites. We compare the properties of purified geothermal silica (PGS) and nanoparticle geothermal silica (NGS) with dried geothermal waste. Through X-ray fluorescence spectroscopy, we determined that GW has a silica content of 93.13%, which significantly increased to 96.02% for PGS and an even higher 99.01% for NGS. Furthermore, our analysis using transmission electron microscopy revealed that NGS exhibited primary particle sizes within the range of 20-50 nm. These disparities in particle size and purities among GW, PGS, and NGS have discernible effects on the properties of rubber composites. Rubber composites employing PGS, with their enhanced purity compared to GW, demonstrated superior tensile strength, with a notable difference of 3.2 N/mm², as well as higher elongation at break, in contrast to those filled with GW. Additionally, the reduction of geothermal silica to a nanoscale size yielded improved filler dispersion within the rubber, as evidenced by scanning electron microscope results. Consequently, rubber composites incorporating NGS exhibited better vulcanization characteristics and mechanical properties when compared to the other samples. The utilization of both PGS, which offers ease of production, and NGS, characterized by its nanoscale dimensions, holds promising benefits for both the rubber industry and geothermal power plants.

Keywords: Geothermal waste, rubber composites, vulcanization, mechanical properties

Part IV Acknowledgements

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