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Plasma nanotechnology for clean energy, green chemistry, and zero-carbon future

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Possible avenues for the plasma nanoscience and nanotechnology to help develop and advance clean, green, and sustainable solutions for the future carbon-emissions-free world are critically examined. The underlying scientific and technological approach is based on synergistic application of plasma electrified, catalytic, and hybrid processes and diverse sustainable feedstocks for the effective up-cycling of carbon-rich precursors. Such processing technologies are aligned with the UN Sustainability Goals and the recommendations of the 2021 Climate Change Conference. The examples considered in the presentation include desalination and resource recovery from sea water, fabrication of high-performance catalysts, electrodes, and membranes, production and storage of sustainable energy, capture and reforming of potent greenhouse gases such as CO2 into value-added fuels, chemical products, materials, etc. Effective decarbonization of industry demands de-centralized clean and renewable energy generation and storage, as well as sustainable and energy-efficient resource recovery. The unique effects of the plasma processing in the advances towards the zero-carbon-emissions technologies that are relevant to major heavy carbon emissions-generating industries are explained. Effective decarbonization necessitates substantially new approaches, such as process electrification (using renewable and clean electric/plasma power P) of the production of materials, chemicals, fuels, and other products (X). This presentation focuses on the applications of plasma-power (plasma-P-to-X) to reform abundant feedstocks (such as industrial and agricultural waste, plastic waste, carbon emissions, environmental pollutants, abundant biomass, and some others) to fabricate advanced functional materials. The produced materials are aimed for applications in diverse technologies such as clean and renewable energy conversion and storage, industrial catalysis, chemical engineering, health, food, environmental, and other technological solutions of vital importance for the sustainable future of our society.

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