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Power of Nanomaterials in Energy Conversion and Storage Applications

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Advanced ceramic materials are driving innovation across all fields of technology, ranging from construction and mechanical engineering, automotive and electromobility, to medical technology, energy storage and conversion technologies, and microelectronics. Nanostructured ceramics and pigments play a key role as advanced photon harvesters, electrode materials in batteries and as electrocatalysts in energy conversion processes. In addition, conjugation of functional groups on the surface of nanoparticles enables immobilization of biocatalysts such as enzymes to degrade microplastics thereby improving the human environment. Moreover, development of biocompatible nanocarriers that can transport anti-tumor drugs in the body represent a major step in the future of precision medicine. Given their technological impact, functional materials represent an essential segment of industrial technologies with significant value creation potential for both established markets and emerging technologies. Especially in the context of sustainable production techniques, substitution of critical raw materials, and energy- and resource-efficient manufacturing, tailored surfaces and interfaces are gaining increasing importance in the future. In this context, plasma-chemical and vapor phase processing of nanostructured ceramics in tuning the functional and interfacial properties for better charge transport, higher corrosion protection and enhanced performance. The examples will include the role of functionalized inorganic surfaces in electrolysers for hydrogen production, 2D materials in Li-ion batteries and advances in photon-harvesting technologies for perovskite-based photovoltaics.