Powering a Sustainable Future with Advanced 2D Nanomaterials for Energy Storage

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Abstract

At Merck KGaA, our Materials Science Nanomaterials R&D team has made significant strides in developing innovative battery materials to tackle critical challenges in energy storage. Our ongoing efforts focus on enhancing battery energy density and cycle life stability by introducing novel materials and processes. Collaborating closely with academic partners, we design and explore a variety of materials for both traditional and emerging battery chemistries, including high energy density composites. In this presentation, we will showcase our recent achievements in developing composite electrodes that exhibit improved energy density and stability across diverse devices, including those manufactured through 3D printing (Figure 1). We will also highlight the potential of MXenes—2D materials known for their high electrical conductivity and mechanical strength—as versatile components in energy storage solutions. Additionally, we will introduce the Electrogreen NMP substitute in battery slurry grades, a greener biodegradable solvent that can dissolve PVDF, providing a safer alternative to conventional toxic solvents. Furthermore, we will present preliminary findings from our research on solid-state electrolytes and the pursuit of sustainable alternatives to conventional battery materials. We will also discuss our recently developed innovative ceramic inks designed for high-temperature applications via 3D printing.

Figures

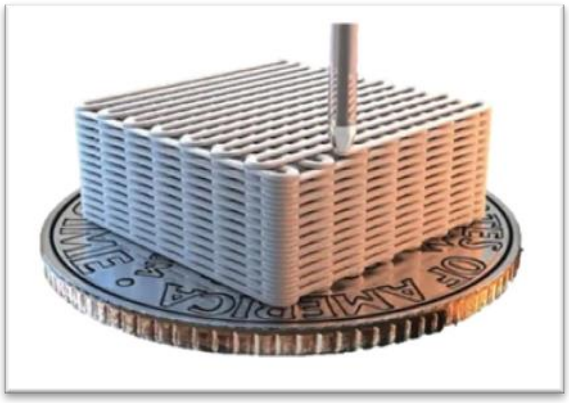

Figure 1: Illustration of 3D-printed battery anode generated using 3D Printable Graphene Oxide Ink (product number 916579)