Innovation in Nanomaterials Synthesis: from Lab to Commercialization

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Nanoengineering plays a pivotal role in optimizing nanomaterials to achieve enhanced performance and impressive mechanical stability, especially in challenging environments. Recent research has been dedicated to the creation of various novel composite materials, encompassing high entropy and multi-elemental nanoparticles, as well as the integration of stable single-atom catalysts onto robust supporting nanomaterials to ensure highly efficient catalytic performance. Effective catalyst design is essential not only for the advancement of chemical sensors but also for energy devices like lithium-air batteries, water-splitting, and CO2 conversion, and more. These active nanomaterials, including catalysts, must resist agglomeration, maintain high thermal stability during repetitive reactions, and necessitate minimal catalyst content for maximal performance. This presentation delves into diverse applications employing electrospun polymer fibers, metal oxide fibers, and carbon fibers. The presentation also outlines an expedited and optimal process for catalyst attachment onto electrospun nanofiber backbone structures. Lastly, a case study traversing the journey from laboratory research to commercialization spotlights the utilization of custom-made electrospinning equipment, roll-to-roll machines with nozzle arrays spanning 35 cm and 1.2 m widths. As electrospinning relies on solution-based processing, we can create a range of fiber types, including colorimetric, thermochromic, and antivirus fibers. Finally, I will conclude by offering insightful perspectives on innovative material synthesis using electrospinning and highlighting interesting case studies of device application.