Bio-based nano-composites for Energy conversion and storage

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The electrification of our production and use of energy is the new paradigm for a sustainable society. Nonetheless, key enabling electrochemical energy conversion and storage technologies are still based on a linear approach to the use of raw materials, which are critical in terms of supply chain for environmental, economic, social, and geo-political factors.

Our research is focusing on combining synthetic biology and nanotechnologies, including electrospinning, as key enabling tools for a new generation of circular bio-based nano-composites to address the issue of critical raw materials for energy systems. Our main targets are electrically conductive biobased thermoplastic composites, which can be used as effective flexible current collectors or directly as active electrodes. Carbon nanofibers as electrically conductive nano-fillers in bio-polymer matrices present unique features for structural and functional properties for fabricating all-carbon electrodes which can be exploited for a number of different applications.

A first application is represented by a class of energy storage devices which is continuously expanding its market and innovation potential: supercapacitors. Among energy storage devices, supercapacitors present unique advantages for their intrinsic superior eco-friendliness and safety, long life, and high charge/discharge rates. We thus decided to face the challenge of developing new advanced concept devices.

A second emerging targeted application are (photo-)bio-electrochemical systems, by “connecting” our materials with intact photosynthetic microorganism, to exploit and tune their metabolism for light energy harvesting and environmental sensing and remediation.

We will present our efforts and preliminary findings in these directions aiming at expanding the potential of circular bio-based materials for our energy systems and devices.