MATERIALS SCIENCE AND TECHNOLOGY

Electrodes & Electrolytes for Potassium Batteries

Funded By	Politecnico di TORINO [P.iva/CF:00518460019]
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Context of the research activity	Electric energy storage technology is becoming more important in the quest to realize a sustainable society. Because electric energy cannot be preserved in its original form, most electric energy is generated from fossil fuels to fit the demand. However, with the ever-increasing concern over global warming, there is much pressure to reduce greenhouse gas emissions and thus, fossil fuel consumption. Although renewable energy collected from renewable resources, such as sunlight, wind, rain, tides, and waves, is favorable, natural resources are intermittent depending on the weather conditions. Thus, to balance the supply and demand of electric power and increase energy efficiency, a large-scale energy storage system that stores the generated energy must be included in a renewable energy power plant. Recently, potassium batteries have attracted much attention as a cost-effective option. Potassium is inexhaustible and thermodynamically forms no Al-K intermetallic compounds, indicating that Al foil can also be applied as a negative-electrode current collector in such batteries. Furthermore, these batteries are expected to offer a higher-voltage operation than that of sodium and even lithium counterparts. The lower standard electrode potential of the K/K+ electrode in carbonate ester electrolyte solution was proven before than that of Li/Li+. This lower standard electrode potential of the K/K+ electrode leads to lower cutoff potentials of the available negative electrodes without metallic potassium deposition. Thus, potassium batteries have the potential of higher-voltage operation in the wider voltage range compared to sodium and lithium counterparts. Furthermore, they can realize high-power densities based on the fast diffusion rate of K+ ions, which have weak Coulombic interactions. These unique advantages of K+ ions make KIBs a possible alternative to lithium ones and have attracted much attention. After the experimental demonstrations of the low K/K+ potential and electrochemical K-intercalation into graphite in 2015, potassium batteries and related materials, including positive/negative electrode materials, nonaqueous electrolytes, solid electrolytes, and functional binders, are starting to be extensively studied.
	The main goal of this PhD activity is the development of a new materials

Objectives	platform for potassium batteries. One of the hugest targets of this PhD activity is that of setting up an interdisciplinary approach that includes: i) Materials design and engineering to obtain working anodes and cathodes, coupled with electrochemical and physico-chemical in-depth analysis; ii) Preparation of polymer electrolytes to ensure long-term stability and safety to potassium batteries; iii) Lab-scale cells assembly and testing; iv) Targeting cutting-edge aims in this field, i.e. the use of CRMs-free and/or biosourced components for cells fabrication.

Skills and competencies for the development of the activity	• Candidates are required to have defended a MSc Thesis in: Energy Engineering; Material Engineering. • Previous activities of the candidates in the field of post-Li batteries (e.g., sodium, potassium, magnesium) constitute a preferential skill for the selection process. • Candidates must demonstrate a strong interest in the proposed topics. • Candidates must demonstrate the already acquired ability to draft scientific documents in English. • Capacity to work in a multidisciplinary team and to prioritize the own work for accomplishing deadlines.