MATERIALS SCIENCE

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TOR VERGATA

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"Solid State Polymer Electrolytes for Electrochemical Energy Technologies"

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Providing highly efficient and environmentally friendly energy storage and conversion technologies is the number one challenge for the sustainable development of mankind in the twenty-first century. Electrochemical energy devices offer in principle high efficiency and might allow reducing or eliminating pollution from internal combustion engine-based cars, trucks and coal-burning power plants, but important materials challenges are still to be solved before large scale and low cost commercial installation can start.

Ion exchange solid conducting membranes have great potential to be applied in energy conversion devices such as electrolysers, fuel cells, redox flow batteries, and solid state rechargeable batteries, which are highly efficient, energy saving and friendly to the environment. Materials for these technologies have been significantly improved over the last decade. However, to match the expectations needed for market penetration, these technologies rely on a significant further improvement of the materials properties, including their ionic conductivity.

Ion transport in most low-temperature conductors is water assisted. In polymer electrolytes, water forms ionic clusters together with counterions and fixed charges thus giving rise to phase separated systems at the nanometric scale, where the clusters are confined within the hydrophobic polymer matrix. Consequently, the proton conductivity of these systems depends not only on carrier concentration and on their mobility but also on cluster connectivity which, in turn, increases with water content.

In this introduction, I will present some fundamental concepts on electrolytic membranes and summarize some of our current research in this domain.