COMBINING SOL-GEL CHEMISTRY AND ELECTROSPINNING PROCESS TO DEVELOP COMPOSITE MEMBRANE WITH SELF HEALING PROPERTIES : APPLICATION IN LI-ION BATTERY AND FUEL CELLS

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ABSTRACT:
Our group proposed electrospinning as an alternative strategy to mix silica and polymer domains intermingled at the nanoscale.[1] In this method, the silica is formed *in situ* during the electrospinning process through sol-gel chemistry in acidic conditions. This approach contrasts with other reported works on hybrid nanofibers in which the silica is condensed in alkali conditions and leads to a clearly defined phase separation with the polymer, *i.e.* with silica particles within or onto the polymer fibers.[2,3] On the contrary, our approach forms interpenetrated networks of a hydrophobic fluorinated polymer and a hydrophilic sulfonated silica along the fibers. This specific organization of inorganic/organic domains allow us to achieve outstanding mechanical properties.[4] They are comparable to spider's web yarn. We have further exploited the specific organization of silica domains within the fibers to bring functionalities to the membranes. In particular, we have used the versatility of the sol-gel chemistry to graft onto silica network various functions including –SO_3H, -SH, amines,… For example, the addition of –SO_3H function to the fibers coupled with the impregnation of the porous network with ionomer allows us the fabrication of hybrid organic/inorganic electrolyte with proton conductivity at high temperature and low humidity competitive to Nafion, the state of the art. Additionally, the grafting of –SO_3Li, and amine functions to the fibers allows the design of porous separator with interesting self-healing properties for application in Li-ion batteries.

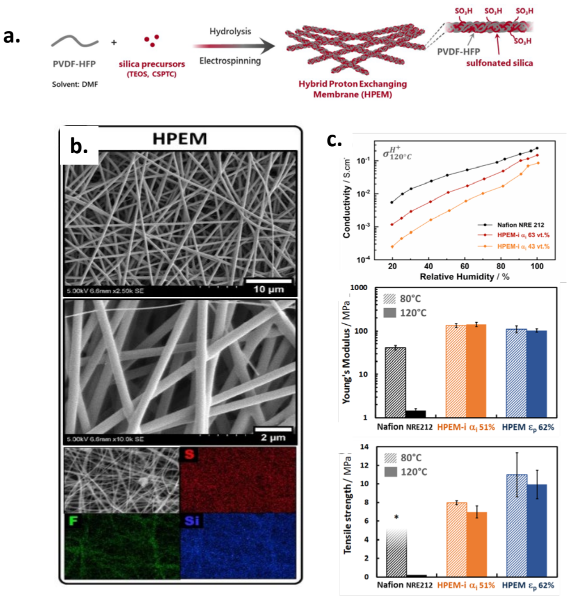

Figure 1 : a. Scheme of the synthesis process of Hybrid Proton Exchanging Membrane (HPEM), b. SEM images and EDX mapping of HPEM c. High-temperature performances of HPEM – ionomer composites. a) Evolution of proton conductivity with relative humidity at 120°C. Mechanical properties of hybrid, ionomer, and composites membranes at 80°C and 120°C measured by stress-strain analysis: b) Young's Modulus, c) ultimate tensile strength. * at least 4 MPa, elongation is too high to go to rupture (150% at 4 MPa)

References

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