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Polymic protic salt membranes, a new approach to the Holy Grail of a solid state proton conductor[1]

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Electrons are readily transported in solids through the electronic conduction band in metals and semiconductors, but ion conduction is not as simple. Most proton conductors are aqueous solutions. Water plays two roles: i) water ionizes dissolved acids (and bases), and ionic conductivity results from the diffusion of protons and anions, a vehicular mechanism; ii) water also has an accessible "proton hopping path" (proton transport via hydrogen bonding and rotations) resulting in higher solution conductivity than by diffusion of ions alone. Some liquids, like phosphoric acid, have been know to conduct only protons with no co-transport of other species, but until recently these have been few in number. Some solids, like polyguanine, conduct only protons, but there have been even fewer reports of these. A proton transfer salt is an equimolar mixture of an acid and a base that internally transfer a proton. Recently, a number of proton transfer salts in the liquid state have been found that can transport proton without water, even at temperatures well above the boiling point of water. Whether a vehicular or hopping transport mechanism operates for these liquid proton transfer salts is under study. Vehicular transport is not possible in a solid membrane made for proton transfer salt formed from a solid polymer with one moiety (e.g., base) covalently fixed into the polymer and with the other moiety (e.g., acid) electrostatically bound after proton transfer. Synthetic strategies and characterization of solid proton conducting membranes, including solid protic transfer salt membranes, will be presented.

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