Norbornene-Based Polymer Electrolytes for Lithium Cells

These solid electrolytes are single-ion conductors.

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Norbornene-based polymers have shown promise as solid electrolytes for lithium-based rechargeable electrochemical cells. These polymers are characterized as single-ion conductors.

Single-ion-conducting polymers that can be used in lithium cells have long been sought. Single-ion conductors are preferred to multiple-ion conductors as solid electrolytes because concentration gradients associated with multiple-ion conduction lead to concentration polarization. By minimizing concentration polarization, one can enhance charge and discharge rates.

Norbornene sulfonic acid esters have been synthesized by a ring-opening metathesis polymerization technique, using ruthenium-based catalysts. The resulting polymer structures (see figure) include sulfonate ionomers attached to the backbones of the polymer molecules. These molecules are single-ion conductors in that they conduct mobile Li+ ions only; the $—SO_3^-$ anions in these polymers, being tethered to the backbones, do not contribute to ionic conduction.

This molecular system is especially attractive in that it is highly amenable to modification through functionalization of the backbone or copolymerization with various monomers. Polymers of this type have been blended with poly(ethylene oxide) to lend mechanical integrity to free-standing films, and the films have been fabricated into solid polymer electrolytes. These electrolytes have been demonstrated to exhibit conductivity of 2×10^{-5} S·cm (which is high, relative to the conductivities of other solid electrolytes) at ambient temperature, plus acceptably high stability.

This type of norbornene-based polymeric solid electrolyte is in the early stages of development. Inasmuch as the method of synthesis of these polymers is inherently flexible and techniques for the fabrication of the polymers into solid electrolytes are amenable to optimization, there is reason to anticipate further improvements.

This work was done by Iris Cheung and Marshall Smart of Caltech and Surya Prakash, Akira Miyazawa, and Jinbo Hu of the University of Southern California for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

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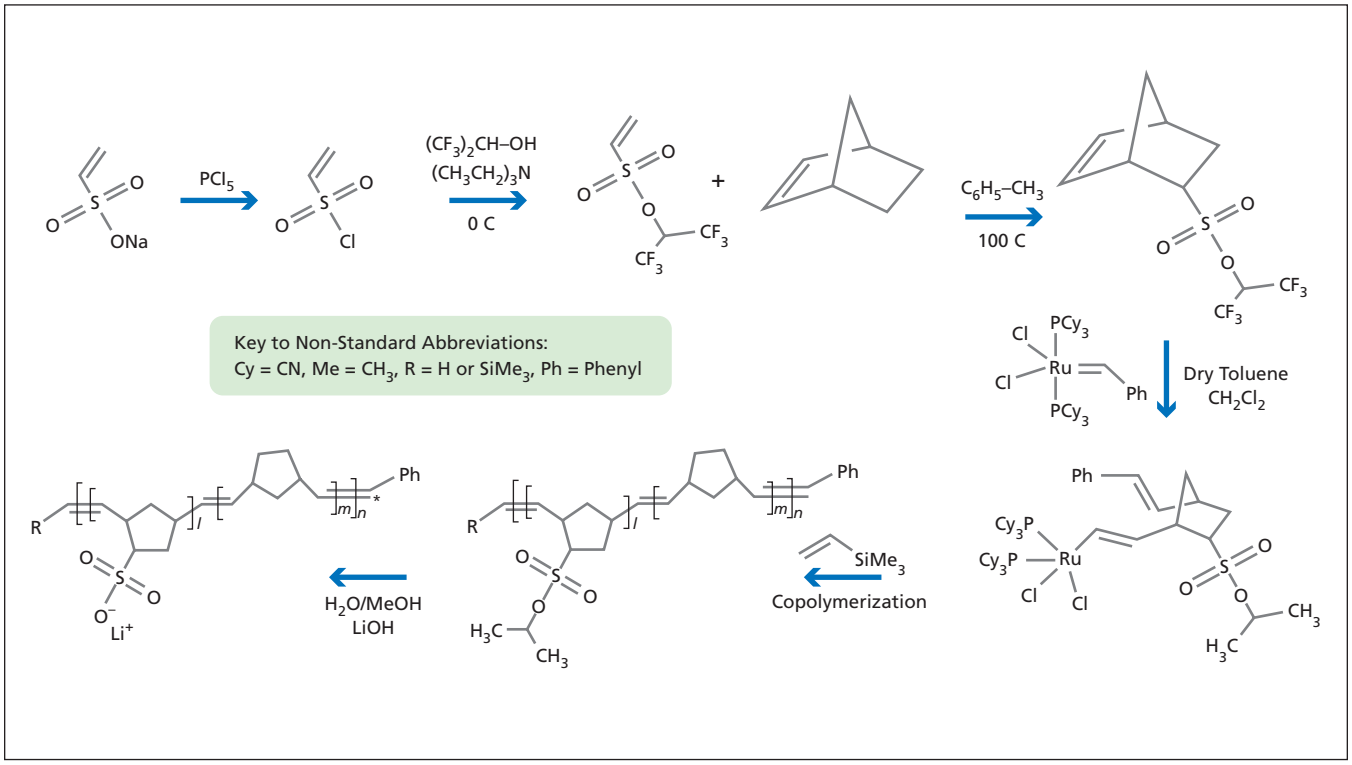

This **Sequence of Reactions** yields a cyclopentane-based polymer structure that includes sulfonate ionomers attached to the backbones. Li^+ ions are loosely bound to the sulfonate ionomers.