



Highly Stable and Active Catalyst for Sabatier Reactions

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Highly active Ru/TiO₂ catalysts for Sabatier reaction have been developed. The catalysts have shown to be stable under repeated shutting down/startup conditions. When the Ru/TiO₂ catalyst is coated on the engineered substrate Fe-

CrAlY felt, activity enhancement is more than doubled when compared with an identically prepared engineered catalyst made from commercial Degussa catalyst. Also, bimetallic Ru-Rh/TiO₂ catalysts show high activity at high throughput.

This work was done by Jianli Hu and Kriston P. Brooks of Battelle Memorial Institute for Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809. MSC-24299-1

Better Proton-Conducting Polymers for Fuel-Cell Membranes

These materials could function while hotter and drier.

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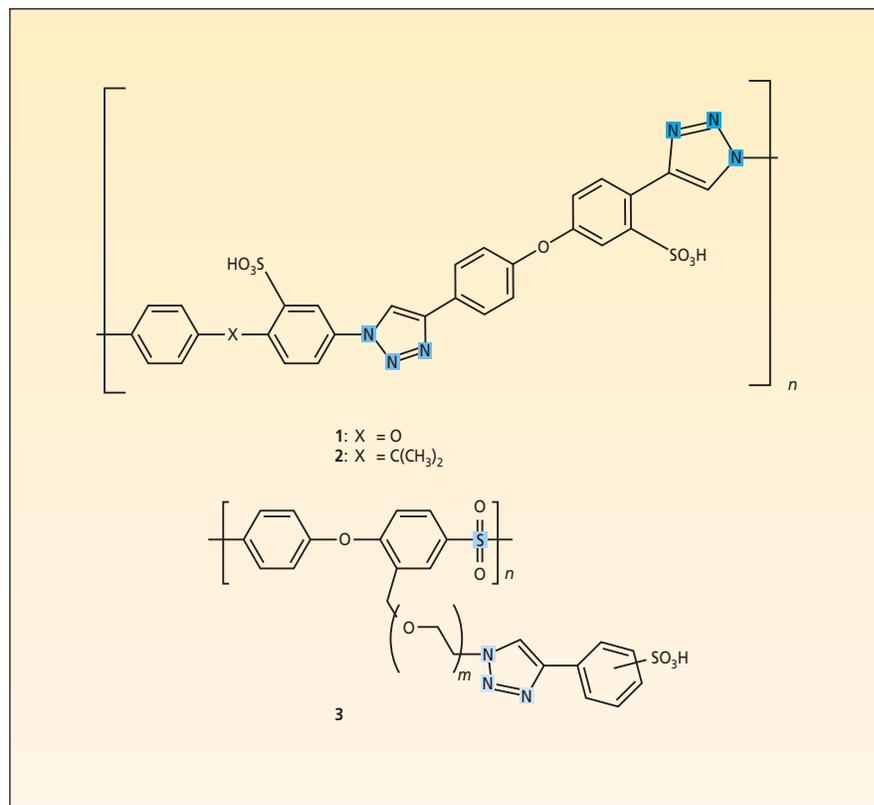
Polyoxyphenylene triazole sulfonic acid has been proposed as a basis for development of improved proton-conducting polymeric materials for solid-electrolyte membranes in hydrogen/air fuel cells. Heretofore, the proton-conducting membrane materials of choice have been exemplified by a family of perfluorosulfonic acid-based polymers (Nafion[®] or equivalent). These materials are suitable for operation in the temperature of 75 to 85 °C, but in order to reduce the sizes and/or increase the energy-conversion efficiencies of fuel-cell systems, it would be desirable to increase temperatures to as high as 120 °C for transportation applications, and to as high as 180 °C for stationary applications. However, at 120 °C and at relative humidity values below 50 percent, the loss of water from perfluorosulfonic acid-based polymer membranes results in fuel-cell power densities too low to be of practical value. Therefore, membrane electrolyte materials that have usefully high proton conductivity in the temperature range of 180 °C at low relative humidity and that do not rely on water for proton conduction at 180 °C would be desirable.

The proposed polyoxyphenylene triazole sulfonic acid-based materials have been conjectured to have these desirable properties. These materials would be free of volatile or mobile acid constituents. The generic molecular structure of these materials is intended to exploit the fact, demonstrated in previous research, that materials that contain ionizable acid and base groups covalently

attached to thermally stable polymer backbones exhibit proton conduction even in the anhydrous state.

The sulfonic acid group in polyoxyphenylene triazole sulfonic acid is a

strong acid capable of generating protons when presented with a suitable base. The triazole moiety offers at least three base sites for protonation. The polyoxyphenylene backbone is endowed



These **Three Generic Molecular Structures** are representative of the proposed polyoxyphenylene triazole sulfonic acid-based compounds. The subscripts *m* and *n* denote integers. These compounds as denoted by their full names are (1) poly[(1H-1,2,3-triazole-1,4-diyl)-co-(oxyphenylenesulfonic acid)], (2) poly[(1H-1,2,3-triazole-1,4-diyl)-co-bisphenylenesulfonic acid]-co-(oxyphenylenesulfonic acid)], and (3) poly[(oxyphenylenesulfone)-graft-1-(1H-1,2,3-triazole-1,4-diyl)-1-poly(ethylene oxide)-4-benzenesulfonic acid)].

with excellent thermal stability, as evidenced by the numerous engineering polymers, incorporating this and related backbones, that can withstand operating temperatures up to 300 °C. Also, polymers that have similar backbones [poly(arylene ether ether ketone) and poly(arylene ether sulfone)] have been reported to be electrochemically stable. Hence, the proposed polymers are expected to exhibit high thermal and electrochemical stability.

Below the boiling temperature of water, the proposed materials could absorb and retain water and could conduct protons by means of the same physical mechanisms as those of prior membrane electrolyte materials that rely on water.

Above the boiling temperature of water, membranes become dehydrated, but membranes made of the proposed materials could still conduct protons by transfer between the acid and base groups on the polymer backbones. Hence, the proposed polymers are expected to conduct protons under anhydrous as well as hydrous conditions.

The figure depicts generic molecular structures of three types of compounds according to the proposal. These compounds could be synthesized from commercially available starting compounds and/or from intermediate compounds that can be synthesized from commercially available starting compounds.

This work was done by Sri Narayan of Caltech and Prakash Reddy of the University of Missouri-Rolla for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov.

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