HYDROGEN PRODUCTION

Liquid metal methane conversion

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Methane is converted to hydrogen industrially via steam methane reforming, but the conversion can also be achieved by pyrolysis. The pyrolysis reaction forms solid carbon, rather than carbon oxides, as a by-product, thus avoiding the need for separation of hydrogen from other gaseous products as in the case of reforming. Metallic catalysts in the solid phase can be used to achieve pyrolytic conversion of methane to hydrogen, but the build-up of solid carbon on the surface of the catalysts leads to rapid deactivation. Now, Horia Metiu, Eric McFarland and colleagues at the Indian Institute of Technology and the University of California, Santa Barbara, use a molten Ni–Bi alloy to stably produce hydrogen by methane pyrolysis.

To produce alloys that melt below 1000 °C, the authors use low-melting-point metals such as Bi, In, Ga, Sn and Pb effectively as solvents for other, high-melting-point metals. While the low-melting-point metals have some catalytic activity on their own, addition of Ni or Pt increases the rate of hydrogen production. The performance of Pt and Ni is comparable in the solid state, but Ni is always more active than Pt for a given, low-melting-point metal solvent. Due to the low density of solid carbon with respect to the metal melt, the produced carbon floats to the surface and can be removed. This feature allows the highest performing metal alloy, comprising 27% Ni dissolved in Bi, to maintain stable activity over 170 hours, in contrast to a solid Ni catalyst that deactivated considerably within one hour. Computation suggests that the active metal is atomically dispersed in the melt and that the atomic charge is key to determining performance.

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