## Reports from Other Journals

# *Nature*: Cleaner Fuels for the Future

by Sabine Heinhorst and Gordon Cannon

Extensive use of fossil fuels is responsible for such environmental problems as acid rain and smog through the release of nitrogen oxides ($NO_x$), which form at high temperatures during combustion. Current research efforts are focused on developing new technologies that employ hydrogen gas as a fuel that is as efficient as coal or oil, yet does not contribute to air pollution. However, the difficulty encountered in safely storing and transporting hydrogen and the expense involved in generating the gas from hydrocarbons severely limit its widespread application. Gaseous hydrocarbons have attracted attention as alternative clean fuels that are more easily handled. Particularly the smallest one, methane, is of interest because of the reduced greenhouse gas emission due to its high hydrogen to carbon ratio. Chemical engineering groups at the University of Pennsylvania and at Massachusetts Institute of Technology recently reported important improvements to existing fuel technology that hold promise for the future use of hydrocarbons as clean and efficient fuels.

The requirement for very high temperatures to ignite and support a methane flame is a serious drawback for the use of this hydrocarbon as a fuel, since these conditions promote the formation of $NO_x$. Zarur and Ying (2000, *403*, January 6 issue, 65–67) have found a way of producing highly effective, durable catalysts that pave the way for efficient methane combustion at lower temperatures. The authors employed a reverse microemulsion to hydrolyze alkoxides of barium and aluminium in a controlled fashion, thereby creating uniformly sized barium hexaaluminate nanoparticles (see Fig. 1). The properties of the nanoparticles could be further improved by depositing cerium oxide on their surface, yielding a catalyst that supports the initiation of methane combustion at low temperature (400 °C). It is stable during high combustion temperatures and resistant to a variety of catalyst poisons.

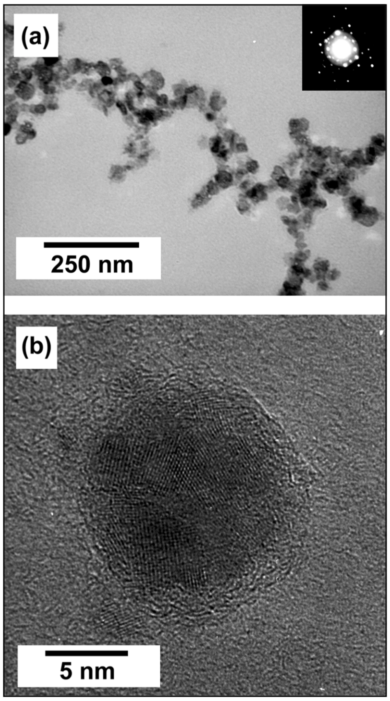


Figure 1. Transmission electron micrographs of barium hexaaluminate nanoparticles (Panels a and b). The insert in Panel a shows an electron diffraction pattern. Reprinted with permission from *Nature* (**2000,** *403*, 65–67), copyright © 2000 Macmillan Magazines Limited.

An alternative to the combustion of hydrocarbons is their oxidation in an electrochemical fuel cell. However, a stumbling block in the development of hydrocarbon-based dry cells has been the finding that the high temperatures needed to promote diffusion of reduced oxygen through the solid ceramic/metal electrolyte connecting the electrodes lead to carbon deposits on the anode that quickly inactivate the cell. The currently used nickel/yttrium/zirconia anodes therefore only support sustained oxidation of hydrogen gas. Park and coworkers (2000, *404*, March 16 issue, 265–267) have experimented with fuel cells that feature a cerium oxide-covered copper anode. Their design exploits the excellent conducting ability of the copper and the efficiency of cerium oxide in catalyzing hydrocarbon oxidation. During long-term (48-h) operation of the so modified fuel cell with methane and other hydrocarbons, such as butane and toluene, no carbon deposits were detected on the anode, and the hydrocarbons had been completely oxidized to carbon dioxide and water.

Two recent commentaries in *Nature*, we think, are both entertaining and informative. One of these is the customary beginning-of-the-year walk through the history of mathematical, scientific, and technological discoveries, which covers an entire millennium (2000, *403*, January 6 issue, 15–16). This year's article features, among others, the discovery of the American continent, breakthroughs in astronomy by Galileo and Kepler, publication of Newton's *Principia*, and it ends with the dawn of molecular biology in the 1950s. The other article (1999, *401*, October 21 issue, 739–740) tackles the seemingly trivial problem of defining a wave. Authors J. A. Scales and R. Snieder illustrate the ubiquitous presence of waves in nature as sound and light, traveling nerve impulses, and space–time ripples. They lead the reader through examples of the often ambiguous distinctions between wave characteristics and properties not associated with waves, only to return to the suggestion for the definition of a wave that was posed at the beginning of their article—namely an organized propagating imbalance.

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