Wax May Provide Cheaper, Safer Rocket Fuel

A scorching blaze lit up the moonscape of Nevada's Black Rock Desert as a 10-foot rocket burst 16,000 feet into the air. The launch was powered by an unlikely but potentially safe and effective new rocket fuel—candle wax.

"It surprised me at first because I don't think of wax as a particularly energetic or powerful rocket fuel," says Brian Cantwell, chair of Stanford University's Aeronautics and Astronautics Department and the Edward C. Wells Professor in the School of Engineering. Cantwell and Research Associate Mustafa Arif Karabeyoglu developed the paraffin wax rocket fuel, which was also used in history's first paraffin-fueled rocket launch almost four years ago.

Paraffin was previously thought to be weak, easily broken, and unsuitable for use as rocket fuel. But Cantwell's team found that it is quite strong—at least twice as strong as conventional solid propellants. The paraffin they use as rocket fuel is the same material used for hurricane candles and sculptor's wax. "Paraffin" is a generic name for a family of simple hydrocarbons with carbon chain lengths ranging from 20 to 40. Different group members are suited to different applications.

Paraffin fuel can contribute significantly to making it safer and cheaper to get into space. "If that were accomplished, human access to space would become more routine, and the ability to do scientific studies and commercialize the use of space would also increase dramatically," Cantwell states. For example, scientists could undertake as many missions as necessary to clean up accumulated debris in our near-space environment.

Conventional rocket fuels are either solids or liquids, but paraffin fuels are used in a hybrid system combining solid and liquid materials. An oxidizer such as oxygen or nitrous oxide is generally used with all fuel types to aid burning.

Hybrid rocket fuels are considered a safer alternative to traditional solid and liquid fuel systems. In hybrids, the thrust chamber contains only solid fuel. This reduces the potential for devastating fires and explosions. The oxidizer is ignited as it is forced over the fuel surface. Like liquid systems, hybrids can be throttled, but require only one set of valves—for the liquid oxidizer.

Cantwell projects that commercial application of paraffin fuels could become a reality in as few as three years. Stanford has secured a patent on the use of paraffin in rocket fuel applications, and Cantwell and Karabeyoglu have started Space Propulsion Group Inc., a company geared toward commercializing the technology.