Spontaneous ignition discovery has ORNL researcher fired up

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Zhiyu Hu believes it is possible to match nature's highly efficient method to convert chemicals into thermal energy at room temperature, and he has data and a published paper to support his theory.
In a paper scheduled to appear in the May 18 print issue of the American Chemical Society's Energy & Fuels, Oak Ridge National Laboratory's Hu describes a novel method to achieve spontaneous ignition and sustained combustion at room temperature. He achieves this "nano-catalytic reaction" with nothing but nanometer-sized particles of platinum stuck to fibers of glass wool in a small jar with methanol and air – with no source of external ignition.

Although this began as little more than a curiosity, Hu quickly realized that the implications could be significant because of the potential gains in energy conversion and utilization. Hu now cites possibilities in the area of distributed power generation and perhaps military and homeland defense.

While additional research needs to be performed to understand the phenomena, Hu notes that natural organisms such as microbes, plants and animals obtain energy from oxidation of the same organic chemicals at their physiological, or body, temperatures. Many of these biological reactions also use metals as part of their enzyme catalysts. Still, this is a surprising result in the field of metal catalysis.

"Since the caveman days, we have burned things to utilize their energy, and the high temperatures and the entire process have created a lot of

problems that we're then forced to deal with," said Hu, a physicist in the Life Sciences Division of the Department of Energy's ORNL.

Citing the wisdom of one of the all-time great scientists, Hu noted that Albert Einstein once said, "Problems cannot be solved at the same level of awareness that created them." So, according to Hu, the best way to solve the energy crisis is to replace our existing fuel consuming method with one that has much higher efficiency and less environmental impact.

Indeed, there is room for efficiency improvement, Hu said, noting that an internal combustion engine is only about 21 percent efficient. The process also creates environmental concerns because of nitrogen oxide emissions that form because of the high combustion temperatures. Even an advanced fuel cell is only about 50 percent efficient, and it must be operated at a temperature that is much higher than our body or room temperature, which requires costly components able to withstand harsh conditions.

"What we have is the possibility of retrieving energy at a lower temperature with greater efficiency and lower environmental effects," Hu said.

The method outlined in the paper "Nano-catalytic spontaneous ignition and self-supporting room-temperature combustion," co-written by ORNL's Vassil Boiadjiev and Thomas Thundat, was discovered unintentionally. Hu was actually conducting another experiment with platinum particles, methanol and cotton swabs when he noticed the mixture produced smoke. He consulted with Thundat and others who encouraged him to figure out what was happening.

"This wasn't research that was funded, so I worked evenings and weekends to try to understand why and how this happened," Hu said. He replicated the discovery numerous times under different conditions and

noticed that the reactions can reach high temperatures of greater than 600 degrees Celsius and low temperatures of just a few tenths of a degree above room temperature.

Hu also learned that he can control the reaction by varying the fuel-air mixture, and he discovered that the process can be dramatically changed by reducing the particle size and changing the particle's morphology, or shape.

Source: Oak Ridge National Laboratory