A hot idea for insulating tiny batteries

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Engineering physics researchers are devising a unique "blanket" that will enable them to squeeze as much electricity as possible from nuclear-powered batteries the size of a grain of coarse salt.

Such batteries, which exploit the natural decay of radioisotopes to generate electricity, could provide virtually indefinite power for micro-technologies like fly-sized robots for military applications or sensors that monitor a building's health.

Other technologies such as fuel cells, chemical batteries or turbine generators also might work in micro-scale applications, says Professor James Blanchard. "But all of them are short-lived," he says. "They either need to be recharged or refueled. Our niche is things that need to be placed and ignored, and just keep running for years."

Nuclear microbatteries convert heat or energy to electricity more efficiently when they are hot, so it makes sense to insulate them, says Blanchard. "The better the insulation, the hotter the source gets, so the more efficient the battery can be," he says.

However, insulating a millimeter-square battery in a way that minimizes heat loss is no easy task. Multifoil insulation is an effective macro-level insulator that combines several thin layers of foil each separated by a vacuum. "They work because they're radiating heat from one layer to another, as opposed to conducting heat through a solid," says Blanchard.

For the microscale, however, multifoil insulation is far too thick.

So, capitalizing on the layered concept, which reduces heat radiation for a fixed temperature drop, Blanchard and graduate student Rui Yao decided to sandwich semicircular silicon oxide pillars-poor conductors-between very thin silicon sheets.

"You want as little conduction through these pillars as possible," says Blanchard.

They developed elaborate computer models to study the heat radiation and conduction of their microscale insulaton. And, using Wisconsin Center for Applied Microelectronics clean room facilities, Yao constructed silicon prototypes.

He now is experimentally verifying what his computer models suggest-that heat is radiating through the silicon layers without much heat loss. "The prototypes he built are a little thicker than the ones we ultimately want to get, but they're consistent with his models," says Blanchard.

Funded by a three-year, $300,000 Department of Energy grant and inspired by an earlier collaboration with Sandia National Laboratory researchers, Blanchard and Yao are still testing and refining the insulation. Implementation for this promising technology, they say, is a couple of years down the road.

"It looks like we'll have an effective insulator that's better than any solid-and better, even, than some of the multi-foil insulations that you can buy commercially," says Blanchard.

Source: University of Wisconsin