New thermal battery manufacturing method to be industrialized

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Sandia researcher Frank Delnick works with a thin-film coating he developed to make thermal battery components. (Photo by Randy Montoya)

(PhysOrg.com) -- A new thin-film coating process for manufacturing thermal batteries used in nuclear weapons and other munitions that was invented at Sandia National Laboratories will be industrialized under a new corporate partnership with a Maryland company. The process could lead to create lighter batteries in a variety of shapes for future applications.

A thermal battery is a nonrechargeable, single-use energy source that can remain inert for years at room temperature before becoming activated at temperatures as high as 1,100 degrees (600 degrees Celsius). The thin-film coating process changes the way some thermal batteries have been made since the 1950s.

Sandia researchers also are looking into whether a patented binder used in the new thin-film coating process has commercial applications, for example in lithium-ion batteries in electric and hybrid vehicles and in batteries used in the petroleum industry when drilling deep underground in hot geothermal environments.

Sandia and ATB Inc., a Cockeysville, Md.-based manufacturer of thermal batteries, recently signed a Cooperative Research and Development Agreement (CRADA) to test Sandia's new thin-film coating process for large-scale industrial production.

"We can take the developments that we've had in the lab, scale up the quantities of materials that we use and instead of producing tens of batteries we can produce hundreds of batteries in ATB's facility," said Tom Wunsch, manager of Sandia's Advanced Power Sources Research & Development Group. "It's beneficial to us to have an industrial partner to work with on these issues and for them to have this new technology."

Guy Chagnon, CEO of ATB, said his company and Sandia have been working independently on changing the process for producing thermal batteries.

"The goal of the CRADA is to industrialize a new process, to manufacture, to build and to test the battery," Chagnon said. "Sandia and ATB have the same vision with the thin-film coating. We're putting our resources together to reduce the size and the cost of thermal batteries."

Sandia's expertise in thermal batteries stems from their use in nuclear weapons and other munitions. They are designed to be extremely reliable, remaining inert for 30 years at room temperature and then springing into action on a moment's notice. Sandia has developed about 30 thermal battery designs since 1975.

Sandia researcher Frank Delnick led the effort to make the thermal battery components as thin-film coatings instead of pellets. The process will work best for thermal batteries that are active for a fraction of a second to a few minutes, he said.

Traditional thermal batteries are made by pressing powdered materials into electrochemically active pellets used as the anode, cathode and separator of the battery. The pellets must be a certain thickness to maintain mechanical integrity and prevent them from falling apart when handled. The amount of material required to achieve mechanical stability can be up to 10 times greater than what is needed to make the battery work. Therefore, considerable reduction in size can be achieved by making the components thinner, Delnick said.

The goal of the agreement is to jointly develop thin-film coatings that will slash the time and materials need to make thermal batteries.

On average, thermal batteries made with thin-film coatings would use one-fifth to one-half the materials needed in their conventionally manufactured counterparts, Delnick said.

The new process also could allow manufacturers to produce different shapes of thermal batteries, Delnick said. Current thermal batteries are cylindrical and range in size from a man's thumb to a one-pound coffee can.

The first thermal battery made using the new process was slightly thicker than a postage stamp and about the size of a quarter, he said.

ATB employees have visited Sandia to learn more about the process and the company is busy readying its facility to begin developing the new manufacturing process. Chagnon said if the research and development are successful, large-scale manufacturing could begin by late 2012.

Sandia's process uses relatively inexpensive equipment common in the paint industry that coats the battery components as thin films onto stainless steel foil. The coatings are held together and bonded to the foil using a patented binder.

The binder must withstand temperatures of about 660-1,100 degrees (350-600 degrees Celsius), which are required to melt the salt electrolyte and activate the battery. Once activated, the binder must remain chemically and mechanically stable throughout the discharge of the battery without emitting gas or producing other side reactions that could adversely affect the performance of the battery, he said.

The coated materials in the batteries are much tougher than those in current models. Delnick expects that thin-film thermal batteries will perform much better in high-shock environments and will be much more amenable to automated manufacturing.

"Since the parts are more robust, you don't have to handle them as gingerly," Delnick said.

The thin-film coating process could be used for select thermal batteries that are being replaced in the B61 thermonuclear weapons as part of a Life Extension Program now under way at Sandia, Wunsch said. That project, the largest weapons refurbishment effort in the U.S. nuclear weapons complex, currently involves hundreds of Sandia employees and is scheduled to begin production in 2017.

Provided by Sandia National Laboratories