Deep Freeze Discovery

USF physicists discover a "new recipe" for solid state refrigeration, bringing efficiency to the process.

TAMPA, Fla. (April 23, 2012) – Physicists from the University of South Florida have discovered a potential new way to advance solid state refrigeration technology, making the evolving field of environmentally-friendly and energy-efficient alternative to conventional refrigeration more efficient.

Solid state refrigeration eschews conventional refrigerants and mechanics to produce cooler temperatures through thermoelectric technology, without the moving parts and chemical refrigerants now commonly used. But despite its anticipated advantages, such technology is not competitive nowadays because of the low efficiency of the solid state refrigerants. Their findings were published in **Physical Review Letters.**

Assistant Professors Inna Ponomareva and Sergey Lisenkov in USF's Department of Physics developed state-of-the-art computational experiments to simulate performance of ferroelectric materials as solid-state refrigerants. Such materials can convert electrical energy into thermal energy and vice versa – known as the electrocaloric effect.

The process works when an electric field is applied to material under certain conditions, causing the temperature to rise. The removal of the electric field will cause the temperature to drop. Thanks to the reversibility of such temperature changes they can be utilized in a refrigeration cycle, the faculty members said.

While the ability of ferroelectric materials to exhibit the electrocaloric effect was known for many decades their practical applications for solid state refrigeration was impossible due to minuscule value of the temperature change. In recent years the interest to the electrocaloric properties of the ferroelectrics has increased enormously, thanks to the predictions of giant electrocaloric effect in ferroelectric nanostructures.

Using the novel computational tool and USF supercomputing resource, the researchers demonstrated a new way to enhance the electrocaloric efficiency. Their method is based on the discovery of coexistence of positive (temperature raise) and negative (temperature drop) electrocaloric effect in the same ferroelectric material. By designing a "special recipe" for a refrigeration cycle that can be created when the positive and negative effects alternate, the efficiency of refrigeration can be greatly enhanced, they reported.