

Properties and Processes for Cryogenic Refrigeration

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Cryogenic temperatures are required for many technology areas, including infrared sensors for surveillance and atmospheric studies; superconducting electronics, magnets, and power systems; to create clean vacuums in semiconductor fabrication processes; for liquefaction of industrial gas; and many other existing and future applications. Proper measurements need to be established to characterize losses within cryocoolers and models need to be developed to optimize the design of such systems. Material properties at cryogenic temperatures also are needed by industry for the design of cryogenic equipment, but the data are difficult to find and interpret.

NIST scientists address issues associated with cryogenic refrigerators, i.e., cryocoolers, and materials performance that are limiting growth in all these technology areas.

http://cryogenics.nist.gov/NewFiles/material_properties.html

This year, we redesigned our web site to provide clear access to references for the database on cryogenic material properties and to graph each property as a function of temperature between about 4 K and 300 K. In addition, we developed two improved measurements techniques (based on hot-wire anemometers) that give good agreement for oscillating flow and used them to measure the complex flow-impedance of an inertance tube. As part of a CRADA with a medical device company, we completed measurements on the performance of a simple pulse tube refrigerator for dermatological pens to about -90°C (such operating temperatures are higher than those normally achieved with pulse tube refrigerators). Using a compressor with a piston-position sensor we were able to characterize the overall system performance for this device.

In the future, we will continue expanding and improving the cryogenic materials database, and developing test methods and improvements in our cryocooler simulation models to address fundamental limitations to the efficiency of cryocooler systems.

A comprehensive article on the fundamentals of cryogenic refrigeration for both small and large superconducting systems was published: "Refrigeration for Superconductors," IEEE Proceedings on Electronic and Large Scale Applications of Superconductivity.