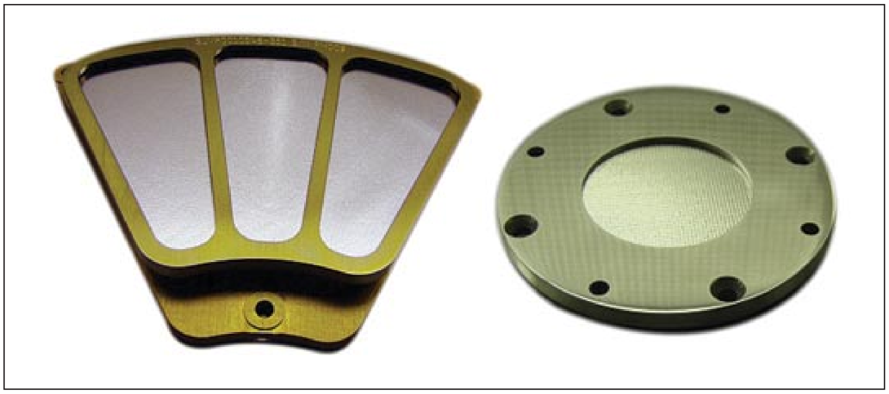
Blocking Filters With Enhanced Throughput for X-Ray Microcalorimetry

Polyimide replaces the standard metal mesh.

Goddard Space Flight Center, Greenbelt, Maryland

New and improved blocking filters (see figure) have been developed for microcalorimeters on several mission payloads, made of high-transmission polyimide support mesh, that can replace the nickel mesh used in previous blocking filter flight designs. To realize the resolution and signal sensitivity of today's x-ray microcalorimeters, significant improvements in the blocking filter stack are needed.



SUVI (Solar Ultraviolet Imager) Entrance Filter Prototype —150 nm Al on 70 lpi polyimide mesh and an ASTRO-H DMS filter prototype — 80 nm Al on 100 nm polyimide with 70 lpi polyimide mesh.

Using high-transmission polyimide support mesh, it is possible to improve overall throughput on a typical microcalorimeter such as Suzaku's X-ray Spectrometer by 11%, compared to previous flight designs. Using polyimide to replace standard metal mesh means the mesh will be transparent to energies 3 keV and higher. Incorporating polyimide's advantageous strength-to-weight ratio, thermal stability, and transmission characteristics permits thinner filter materials, significantly enhancing throughput. A prototype contamination blocking filter for ASTRO-H has passed QT-level acoustic testing. Resistive traces can also be incorporated to provide decontamination capability to actively restore filter performance in orbit.

This work was done by David Grove, Jacob Betcher, and Mark Hagen of Luxel Corp. for Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-16292-1

High-Thermal-Conductivity Fabrics

Applications include cooling garments for firefighters, hazmat personnel, soldiers, and in cooling vests for multiple sclerosis patients.

Lyndon B. Johnson Space Center, Houston, Texas

Heat management with common textiles such as nylon and spandex is hindered by the poor thermal conductivity from the skin surface to cooling surfaces. This innovation showed marked improvement in thermal conductivity of the individual fibers and tubing, as well as components assembled from them.

The problem is centered on improving the heat removal of the liquid-cooled ventilation garments (LCVGs) used by astronauts. The current design uses an extensive network of water-cooling tubes that introduces bulkiness and discomfort, and increases fatigue. Range of motion and ease of movement are affected as well. The current technology is the same as developed during the Apollo program of the 1960s. Tubing material is hand-threaded through a spandex/nylon mesh layer, in a series of loops throughout the torso and limbs such that there is close, form-fitting contact with the user. Usually, there is a nylon liner layer to improve comfort. Circulating water is chilled by an external heat exchanger (sublimator).

The purpose of this innovation is to produce new LCVG components with improved thermal conductivity. This was addressed using nanocomposite engineering incorporating high-thermal-conductivity nanoscale fillers in the fabric and tubing components. Specifically, carbon nanotubes were added using normal processing methods such as thermoplastic melt mixing (compounding twin screw extruder) and downstream processing (fiber spinning, tubing extrusion). Fibers were produced as yarns and woven into fabric cloths. The application of isotropic nanofillers can be modeled using a modified Nielsen Model for conductive fillers in a matrix based on Einstein's viscosity model.

This is a drop-in technology with no additional equipment needed. The loading is limited by the ability to maintain adequate dispersion. Undispersed materials will plug filtering screens in processing equipment. Generally, the viscosity increases were acceptable, and allowed the filled polymers to still be processed.