rial to be removed from mandrels after a heat-forming process. Without a specific removal process, mold release agents may continue to adhere to the surface of the composite material, thereby affecting the bonding of other materials that may come into contact with the composite surface in later stages of processing.

Mold release agents have a unique chemistry that, upon heating, requires a unique chemical method for removal. Prior art includes immersion solvent cleaning (trichloroethylene, hexane, limonene), vapor degreasing, and plasma cleaning. Many of the solvent and vapor degreasing techniques, such as Freon and trichloroethylene, can no longer be used per EPA standards. Plasma cleaning has limited use in structures that have a deep channel or high aspect ratio, as the plasma penetrates diffusively and thus, may result in incomplete cleaning for the full depth of the structure.

A constituent common to commercially available household cleaning agents is employed for the removal of mold release agents common to the manufacturing of heat-formed composite materials. The reliability of the solvent has been proven by the longevity and reliability of commercial household cleaners. At the time of this reporting, no one has attempted using constituent for this purpose. The material to be cleaned is immersed in the solution, vertically removed so that the solution is allowed to drain along cell walls and into a solvent bath, and then placed on a compressed airflow table for drying. Non-destructive evaluation techniques [see "Non-Destructive Evaluation of Materials via Ultraviolet Spectroscopy" (GSC-15338), *NASA Tech Briefs,* Vol. 32, No. 6 (June 2008) p. 81] are employed to detect mold release residue and evaluate the degree of cleanliness. The cleaning process is repeated until non-destructive evaluation shows minimal detection limits for mold release residue.

This work was done by Diane Pugel of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-15902-1

Infrared-Bolometer Arrays With Reflective Backshorts

Operational wavelengths can be tailored by adjusting a few process steps.

Goddard Space Flight Center, Greenbelt, Maryland

Integrated circuits that incorporate square arrays of superconducting-transition-edge bolometers with optically reflective backshorts are being developed for use in image sensors in the spectral range from far infrared to millimeter wavelengths. To maximize the optical efficiency (and, thus, sensitivity) of such a sensor at a specific wavelength, resonant optical structures are created by placing the backshorts at a quarter wavelength behind the bolometer plane. The bolometer and backshort arrays are fabricated separately, then integrated to form a single unit denoted a backshort-under-grid (BUG) bolometer array. In a subsequent fabrication step, the BUG bolometer array is connected, by use of single-sided indium bump bonding, to a readout device that comprises mostly a superconducting quantum interference device (SQUID) multiplexer circuit. The resulting sensor unit comprising the BUG bolometer array and the readout device is operated at a temperature below 1 K.

The concept of increasing optical efficiency by use of backshorts at a quarter wavelength behind the bolometers is not new. Instead, the novelty of the present development lies mainly in several features of the design of the BUG bolometer array and the fabrication sequence used to implement the design. Prior to joining with the backshort array, the bolometer array comprises, more specifically, a square grid of free-standing molybdenum/gold superconducting-transition-edge bolometer elements on a 1.4-μm-thick top layer of silicon that is part of a silicon support frame made from a silicon-on-insulator wafer. The backshort array is fabricated separately as a frame structure that includes support beams and contains a corresponding grid of optically reflective patches on a single-crystal silicon substrate.

The process used to fabricate the bolometer array includes standard patterning and etching steps that result in the formation of deep notches in the silicon support frame. These notches are designed to interlock with the support beams on the backshort-array structure to provide structural support and precise relative positioning. The backshort-array structure is inserted in the silicon support frame behind the bolometer array, and the notches in the frame serve to receive the support beams of the backshort-array structure and thus determine the distance between the backshort and bolometer planes. The depth of the notches and, thus, the distance between the backshort and bolometer planes, can be tailored to a value between 25 to 300 μm adjusting only a few process steps. The backshort array is designed so as not to interfere with the placement of indium bumps for subsequent indium bump-bonding to the multiplexing readout circuitry.

This work was done by Timothy M. Miller, John Abrahams, and Christine A. Allen of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-15104-1