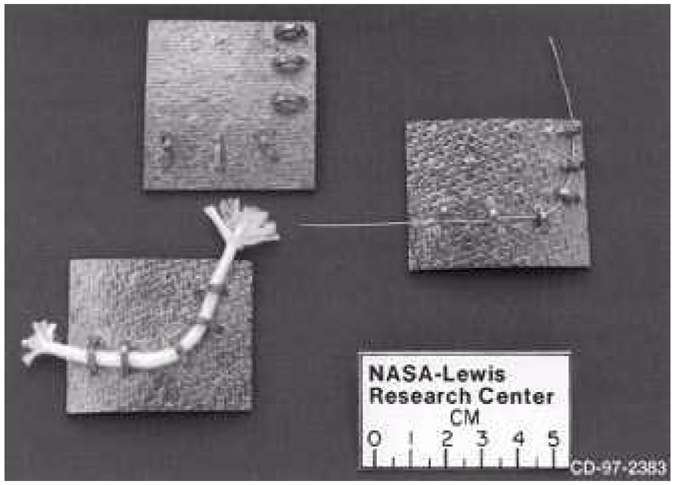
Sensor Lead Wires Positioned on SiC-Based Monolithic Ceramic and Fiber-Reinforced Ceramic Matrix Composite Subcomponents With Flat and Curved Surfaces

There is strong interest in the development of silicon carbide-based monolithic ceramic and composite materials and components for demanding, high-temperature applications. Thorough characterization of material properties, including high-temperature testing under simulated or actual operating conditions, is a high priority for programs involved in developing these silicon carbide- (SiC) based materials and components.

Members of the Sensors and Electronics Technology Branch at the NASA Lewis Research Center are developing minimally intrusive methods of measuring the properties (such as the surface temperature, strain, and heat flux characteristics) of components and subelements that are being tested or operated in hostile, high-temperature environments. Their primary goal is to instrument the test article or operating component with durable sensors that have a minimal effect on test conditions such as the gas flow across the surface of the item and the material response (including the through-thickness conduction of heat). Therefore, the main thrust of their work has been the development of thin-film sensors (e.g., thermocouples or strain gauges) for use on various advanced material test articles, including SiC/SiC composite components.

There was a need for a better method of securing sensor lead wires on SiC-based components and subelements that would be tested at temperatures to 1000 °C (or higher), to enhance the durability of the overall minimally intrusive sensor system. To address this need, Lewis researchers devised an alternative approach for positioning the sensor lead wires (which are connected to the thin-film sensors) on SiC or SiC/SiC components. A reaction-forming method of joining was used to strongly bond hoop-shaped monolithic SiC and SiC/SiC composite attachments of various sizes to both flat and curved surfaces of SiC/SiC composite subelements (see the photos). This approach is based on an affordable, robust ceramic joining technology, named ARCJoinT, which was developed at Lewis for the joining of SiC-based ceramics and fiber-reinforced composites.



SiC hoops joined to SiC/SiC composite panels. These attachments are used to position and secure sensor lead wires.

SiC hoops successfully attached (via reaction joining) to a SiC/SiC composite subelement having a curved surface.

The ability to join these attachments to a curved surface is important because many SiC/SiC components that need to be tested have some curved surfaces. The use of thin attachment hoops having a radius slightly larger than the diameter of the sensor lead wire cable should (1) prevent the wires from moving, which reduces the risk of sensor failure, (2) minimize the disruption of high-velocity combustion or cooling gas flow, and (3) minimize the influence of the attachments on component performance during testing under simulated engine conditions because the hoops have minimal contact with the test article. On the basis of results obtained in previous joining studies, the joined attachments should maintain their integrity at temperatures up to 1350 °C in air. Preliminary testing under static high-temperature conditions has yielded positive results.

The projected excellent high-temperature strength of the joined attachments should make it possible to obtain better sensor durability than has previously been achieved by using refractory, adhesive cement to secure lead wire assemblies. This novel approach is being evaluated further through burner rig testing of instrumented panels to determine the potential for obtaining enhanced durability, minimally intrusive, high-temperature sensor systems. The technology apparently could also be used to reinstall attachments on ceramic components that have been damaged in service.

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