Mechanics

SiC-Based Miniature High-Temperature Cantilever Anemometer

This compact, minimally intrusive sensor functions at temperature as high as 600 °C.

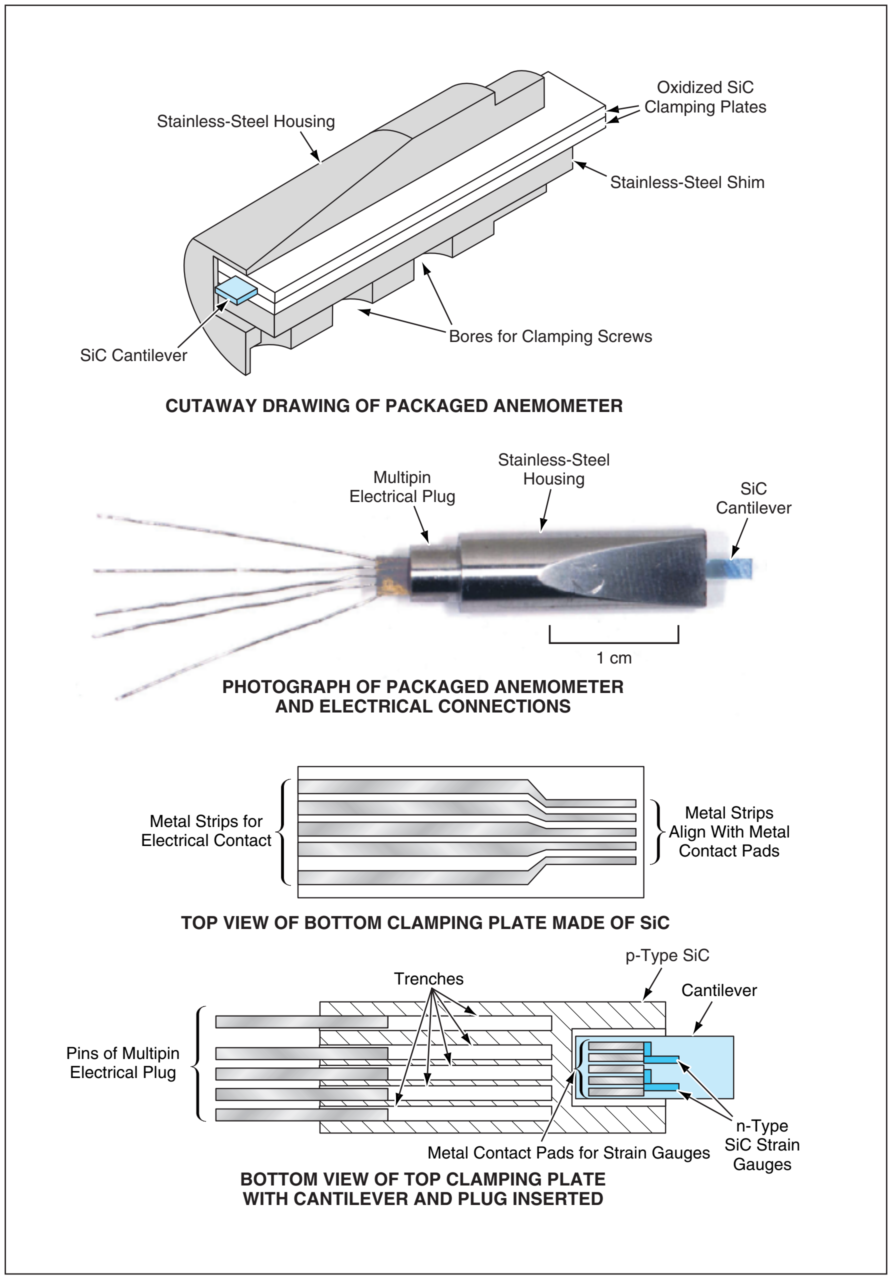
John H. Glenn Research Center, Cleveland, Ohio

The figure depicts a miniature cantilever-type anemometer that has been developed as a prototype of compact, relatively nonintrusive anemometers that can function at temperatures up to 600 °C and that can be expected to be commercially mass-producible at low cost. The design of this anemometer, and especially the packaging aspect of the design, is intended to enable measurement of turbulence in the high-temperature, high-vibration environment of a turbine engine or in any similar environment.

The main structural components of the anemometer include a single-crystal SiC cantilever and two polycrystalline SiC clamping plates, all made from chemical-vapor-deposited silicon carbide. Fabrication of these components from the same basic material eliminates thermal-expansion mismatch, which has introduced spurious thermomechanical stresses in cantilever-type anemometers of prior design.

The clamping plates are heavily oxidized to improve electrical insulation at high temperature. A cavity that serves as a receptacle for the clamped end of the cantilever is etched into one end of one clamping plate. Trenches that collectively constitute a socket for a multipin electrical plug (for connection to external electronic circuitry) are etched into the opposite end of this clamping plate. Metal strips for electrical contact are deposited on one face of the other clamping plate. Piezoresistive single-crystal SiC thin-film strain gauges are etched in the n-type SiC epilayer in a Wheatstone-bridge configuration. Metal contact pads on the cantilever that extend into the clamping-receptacle area, are obtained by deposition and patterning using standard semiconductor photolithography and etching methods.

The cantilever and the two clamping plates are assembled into a sandwich structure that is then clamped in a stainless-steel housing. The Wheatstone-bridge carrying SiC cantilever with the metal contact pads on the piezoresistors is slid into the receptacle in the bottom clamping plate. The top clamping plate is brought into contact with the bottom plate so that the narrow section of the metal strips on the top clamp plate aligns with the metal contact pads on the cantilever. When the parts are clamped together, the metal strips provide electrical connections between the Wheatstone-bridge contact points and the sides the trenches that constitute the socket for the multipin electrical plug. Hence, to connect the Wheatstone bridge to ex-



This **Cantilever-Type Anemometer** is an integral combination of functional and packaging components that, together, afford the ability to withstand high temperature, "plug-and-play" functionality, and mass-producibility.

ternal circuitry for processing of the anemometer readout, one need only insert the plug in the socket.

In operation, the cantilever end of the stainless-steel housing is mounted flush with an engine wall and the unclamped portion of the cantilever is exposed into the flow. The cantilever is deflected in direct proportion to the force induced by component of flow parallel to the engine wall and perpendicular to the broad exposed face of the cantilever. The maximum strain on the cantilever occurs at the clamped edge and is measured by the piezoresistors, which are located there. The corresponding changes in resistance manifest themselves in the output of the Wheatstone bridge.

This work was done by Robert S. Okojie, Gustave Fralick, and George J. Saad of **Glenn Research Center**. *Further information is contained in a TSP (see page 1).*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Commercial Technology Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-17222.

Inlet Housing for a Partial-Admission Turbine

The housing is shaped to smooth the inlet flow.

Marshall Space Flight Center, Alabama

An inlet housing for a partial-admission turbine has been designed to cause the inlet airflow to make a smooth transition from an open circular inlet to an inlet slot. The smooth flow is required for purposes of measuring inlet flow characteristics and maximizing the efficiency of the turbine.

A partial-admission turbine is a turbine in which the inlet slot occupies less than a complete circle around the rotor axis. In this case, the inlet slot occupies a 90° arc. The present special inlet-housing design is needed because the "bull nose" shape of a conventional turbine inlet housing fails to provide the required smooth transition in a partial-admission configuration and thereby gives rise to a loss of turbine efficiency and inaccuracies in inlet flow measurements.

Upon entering the inlet housing through the circular opening, the flow encounters a "tongue"-shaped passageway, which serves as a ramp that diverts the flow to the first of two straight passages. This first passageway occupies a 90° arc and has a length equal to two passage heights. Instrumentation rakes for measuring the characteristics of the inlet flow are installed in this passageway.

Just past the first straight passageway is the second one, which is narrower and leads to the 90° turbine inlet slot. This passageway is used to smooth the flow immediately prior to its passage through the turbine inlet slot. The length of this second passageway equals the length of the chord of a turbine vane.

The inlet housing incorporates small ports for measuring static pressures at various locations of the flow, and incorporates bosses for the installation of the instrumentation rakes. The inlet housing also includes a flange at its inlet end for attachment to a circular inlet duct and a flange at its outlet end for attachment to the outer casing of the turbine.

This work was done by Ralph Moye, William Myers, and Kevin Baker of **Marshall Space Flight Center.** *Further information is contained in a TSP (see page 1).*
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