Computer-controlled motorized translation stages are used to automatically position the transducers at specified locations. Scanning is performed in the sense that the measurement, data-acquisition, and data-analysis processes are repeated at different specified transducer locations in an array that spans the specimen surface (or a specified portion of the surface).

A pneumatic actuator with a load cell is used to apply a controlled contact force.

In analyzing the measurement data for each pair of transducer locations in the scan, the total (multimode) acousto-ultrasonic response of the specimen is utilized. The analysis is performed by custom software that extracts parameters of signals in the time and frequency domains.

The computer hardware and software provide both real-time and post-scan processing and display options. For example, oscilloscope displays of waveforms and power spectral densities are available in real time. Images can be computed while scanning continues. Signals can be digitally preprocessed and/or postprocessed by filtering, windowing, time-segmenting, and running-waveform-averaging algorithms. In addition, the software affords options for off-line simulation of the waveform-data-acquisition and scanning processes.

In tests, the system has been shown to be capable of characterizing microstructural changes and defects in SiC/SiC and C/SiC ceramic-matrix composites. Delaminations, variations in density, microstructural changes attributable to infiltration by silicon, and crack-space indications (defined in the next sentence) have been revealed in images formed from several time- and frequency-domain parameters of scanning acousto-ultrasonic signals. The crack-space indications were image features that were not revealed by other nondestructive testing methods and are so named because they turned out to mark locations where cracking eventually occurred.

This work was done by Don Roth of **Glenn Research Center***; Richard Martin, Harold Kautz, and Laura Cosgriff of Cleveland State University; and Andrew Gyekenyesi of Ohio Aerospace Institute. 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-17601-1.

Correction for Thermal EMFs in Thermocouple Feedthroughs

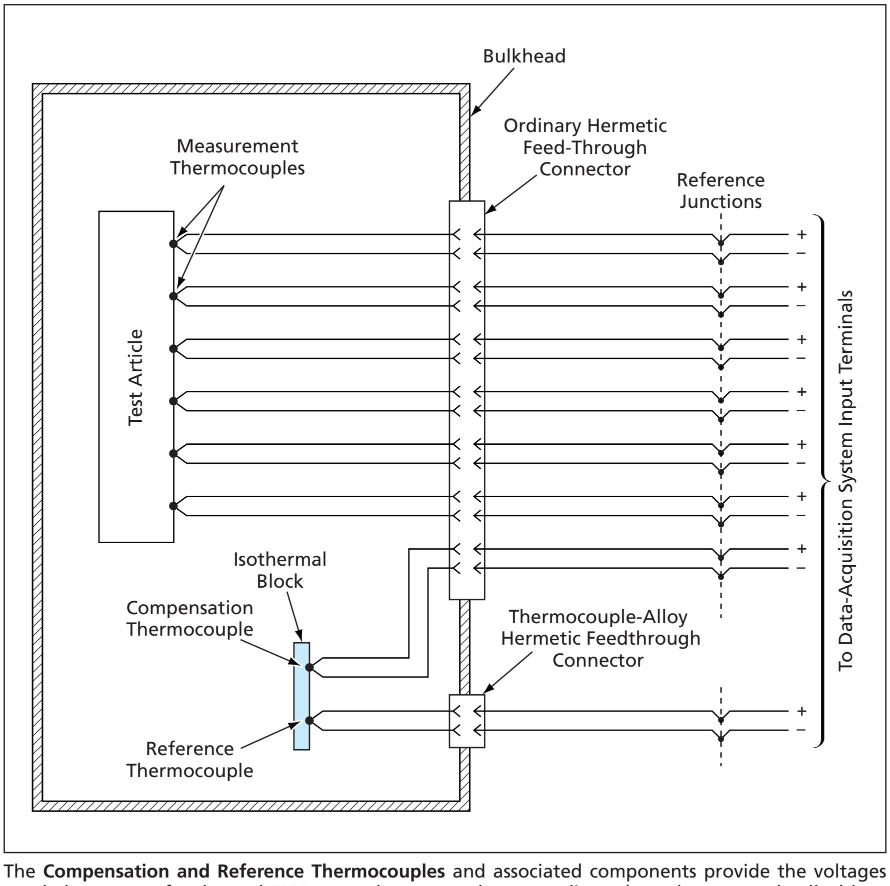
Expensive thermocouple-alloy multipin hermetic feedthrough connectors are no longer necessary.

John H. Glenn Research Center, Cleveland, Ohio

A straightforward measurement technique provides for correction of thermal-electromotive-force (thermal-EMF) errors introduced by temperature gradients along the pins of non-thermocouple-alloy hermetic feedthrough connectors for thermocouple extension wires that must pass through bulkheads. This technique is an alternative to the traditional technique in which the thermal-EMF errors are eliminated by use of custom-made multipin hermetic feedthrough connectors that contain pins made of the same alloys as those of the thermocouple extension wires.

One disadvantage of the traditional technique is that it is expensive and time-consuming to fabricate multipin custom thermocouple connectors. In addition, the thermocouple-alloy pins in these connectors tend to corrode easily and/or tend to be less rugged compared to the non-thermocouple-alloy pins of ordinary connectors. As the number of thermocouples (and thus pins) is increased in a given setup, the magnitude of these disadvantages increases accordingly.

The present technique is implemented by means of a little additional hardware and software, the cost of which is more than offset by the savings incurred through the use of ordinary instead of thermocouple connectors.



The **Compensation and Reference Thermocouples** and associated components provide the voltages needed to correct for thermal-EMF errors that occur when an ordinary (non-thermocouple-alloy) hermetic feedthrough connector is used.

The figure schematically depicts a typical measurement setup to which the technique is applied. The additional hardware includes an isothermal block (made of copper) instrumented with a reference thermocouple and a compensation thermocouple. The reference thermocouple is connected to an external data-acquisition system (DAS) through a two-pin thermocouple-alloy hermetic feedthrough connector, but this is the only such connector in the apparatus. The compensation thermocouple is connected to the DAS through two pins of the same ordinary multipin connector that connects the measurement thermocouples to the DAS.

It is assumed that all the pins in the ordinary connector, including those for the compensation thermocouple, are subjected to the same temperature gradient. To ensure this, the extension wires of the compensation thermocouple must be routed close to those of the measurement thermocouple for distance on the order of a meter on both sides of the bulkhead and connector.

The thermal-EMF error manifests itself as an offset potential, V_O, having the same value in all the thermocouple channels passing through the ordinary connector. Hence, the offset potential is present in the compensation-thermocouple channel. However, the offset potential is not present in the reference-thermocouple channel because this channel contains the thermocouple-alloy connector. Because the compensation and reference thermocouples are at the same temperature (the temperature of the isothermal block), the offset potential can be found through subtraction of the voltages in the compensation and reference channels:

$$V_O = V_B - V_R$$

where V_B is the uncorrected voltage in the compensation channel and V_R is the voltage in the reference channel. It is worthwhile to note that although these thermocouple voltage readings from the block are used to calculate V_O, the block temperature need not be known explicitly; hence, no attempt is made to determine it.

The DAS software performs the thermal-EMF correction by simply subtracting the offset potential from the voltage in each measurement-thermocouple channel. The corrected voltage is then used to calculate the temperature of the thermocouple in the standard manner, by use of a voltage-to-temperature conversion polynomial for the particular thermocouple type and reference junction temperature.

This work was done by Robert A. Ziemke 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-17491-1.

Using Quasiparticle Poisoning To Detect Photons

A mesoscale quantum phenomenon would be exploited to obtain high sensitivity.

NASA's Jet Propulsion Laboratory, Pasadena, California

According to a proposal, a phenomenon associated with excitation of quasiparticles in certain superconducting quantum devices would be exploited as a means of detecting photons with exquisite sensitivity. The phenomenon could also be exploited to perform medium-resolution spectroscopy. The proposal was inspired by the observation that Coulomb blockade devices upon which some quantum logic gates are based are extremely sensitive to quasiparticles excited above the superconducting gaps in their leads. The presence of quasiparticles in the leads can be easily detected via the charge states. If quasiparticles could be generated in the leads by absorption of photons, then the devices could be used as very sensitive detectors of electromagnetic radiation over the spectral range from x-rays to submillimeter waves.

The devices in question are single-Cooper-pair boxes (SCBs), which are mesoscopic superconducting devices developed for quantum computing. An SCB consists of a small superconducting island connected to a reservoir via a small tunnel junction and connected to a voltage source through a gate capacitor. An SCB is an artificial two-level quantum system, the Hamiltonian of which can be controlled by the gate voltage. One measures the expected value of the charge of the eigenvectors of this quantum system by use of a radio-frequency single-electron transistor. A plot of this expected value of charge as a function of gate voltage resembles a staircase that, in the ideal case, consists of steps of height 2 e (where e is the charge of one electron).

Experiments have shown that depending on the parameters of the device, quasiparticles in the form of "broken" Cooper pairs present in the reservoir can tunnel to the island, giving rise to steps of 1 e. This effect is sometimes called "poisoning." Simulations have shown that an extremely small average number of quasiparticles can generate a 1-e periodic signal.

In a device according to the proposal, this poisoning would be turned to advantage. Depending on the wavelength, an antenna or other component would be used to couple radiation into the reservoir, wherein the absorption of photons would break Cooper pairs, thereby creating quasiparticles that, in turn, would tunnel to the island, creating a 1-e signal. On the basis of conservative estimates of device parameters derived from experimental data and computational simulations that fit the data, it has been estimated that the noise equivalent power of a device according to the proposal could be as low as 6×10^{-22} W/Hz$^{1/2}$. It has also been estimated that the spectroscopic resolution (photon energy ÷ increment of photon energy) of such a device in visible light would exceed 100.

This work was done by Pierre Echternach and Peter Day of Caltech for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1).*
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