Dual Cryogenic Capacitive Density Sensor

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vA dual cryogenic capacitive density sensor has been developed. The device contains capacitive sensors that monitor two-phase cryogenic flow density to within ±1% accuracy, which, if temperature were known, could be used to determine the ratio of liquid to gas in the line. Two of these density sensors, located a known distance apart, comprise the sensor, providing some information on the velocity of the flow.

This sensor was constructed as a proposed mass flowmeter with high data acquisition rates. Without moving parts, this device is capable of detecting the density change within a two-phase cryogenic flow more than 100 times a second. Detection is enabled by a series of two sets of five parallel plates with stainless steel, cryogenically rated tubing. The parallel plates form the two capacitive sensors, which are measured by electrically isolated digital electronics. These capacitors monitor the dielectric of the flow — essentially the density of the flow — and can be used to determine (along with temperature) the ratio of cryogenic liquid to gas. Combining this information with the velocity of the flow can, with care, be used to approximate the total two-phase mass flow.

The sensor can be operated at moderately high pressures and can be lowered into a cryogenic bath. The electronics have been substantially improved over the older sensors, incorporating a better microprocessor, elaborate ground loop protection and noise limiting circuitry, and reduced temperature sensitivity. At the time of this writing, this design has been bench tested at room temperature, but actual cryogenic tests are pending

This work was done by Robert Youngquist of Kennedy Space Center and Carlos Mata, Peter Vokrot, and Robert Cox of ASRC Aerospace Corporation. Further information is contained in a TSP (see page 1). KSC-13058

Hail Monitor Sensor

This method of hail monitoring would be useful for the military and the commercial airline industry.

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Figure 1 shows damage to the space shuttle's external tank (ET) that was likely caused by a pea-sized hailstone. Because of the potential damage to the ET while exposed to the weather, it is important to remotely monitor the hail fall in the vicinity of the shuttle pad. If hail of sufficient size and quantity is detected by a hail-monitoring system, the ET would be subsequently thoroughly inspected for damage.

An inexpensive and simple hail monitor design has been developed that has a single piezoelectric ceramic disc and uses a metal plate as a sounding board. The structure is durable and able to withstand the launch environment. This design has several advantages over a multi-ceramic sensor, including reduced cost and complexity, increased durability, and improvement in impact response uniformity over the active surface. However, the most important characteristic of this design is the potential to use frequency discrimination between the spectrum created from raindrop impact and a hailstone impact. The sound of hail hitting a metal plate is distinctly different from the sound of rain hitting the same plate.

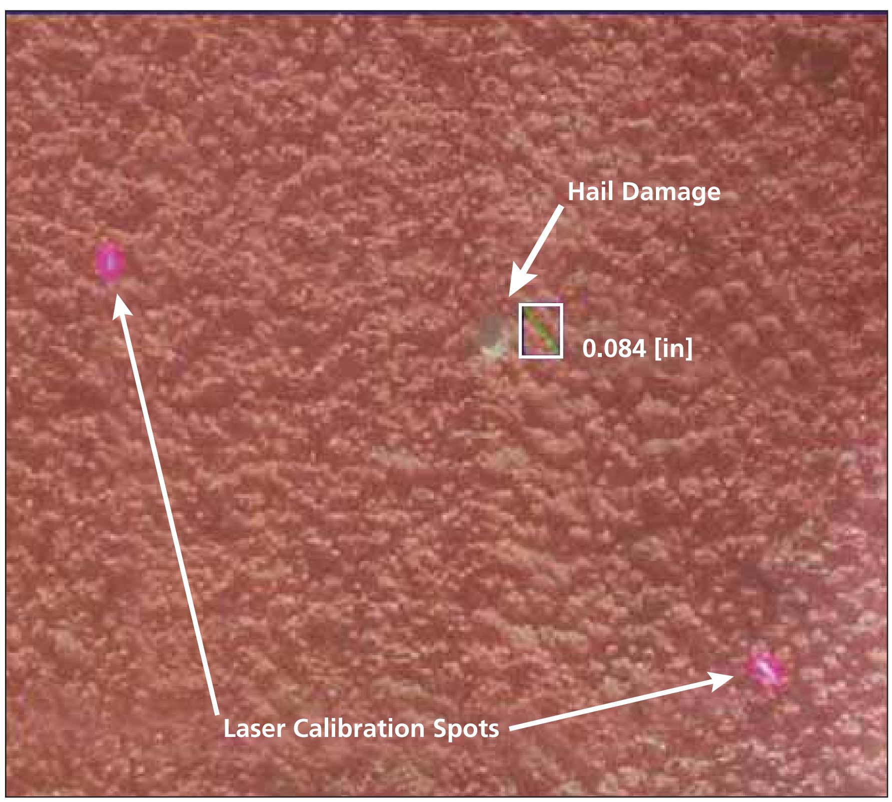

Figure 1. This **Example of Hail Damage** on the surface of the shuttle's external tank likely was caused by a pea-sized hailstone.