Insight — Application Note 2.08

Sample Preparation for Dielectric Measurements

Sensor cleaning

Clean sensors with acetone, alcohol or other solvent to remove oils and contaminants. Solvent or water adsorbed onto the surface of the sensor normally will not interfere with cure monitoring because it is released at elevated temperatures and would not be present at typical process temperatures.

At room temperature, however, adsorbed solvent or water may appear as an additional conductance that can produce erroneous dielectric measurements.

- Heating the sensor above 100 °C for a short time should remove adsorbed solvents.

Sample lay-up

1. To prevent adhering of sample material to a sensor, apply mold release to molds and to the face of ceramic sensors.

- Use silicone based or non-conductive mold release.

2. To prevent a short circuit between the bond pads, sensors with attached leads should not contact electrically conductive surfaces.

- Prevent short circuits of the sensor by covering the bond pads with Kapton® or polyimide tape, as shown in Figure 8-1.

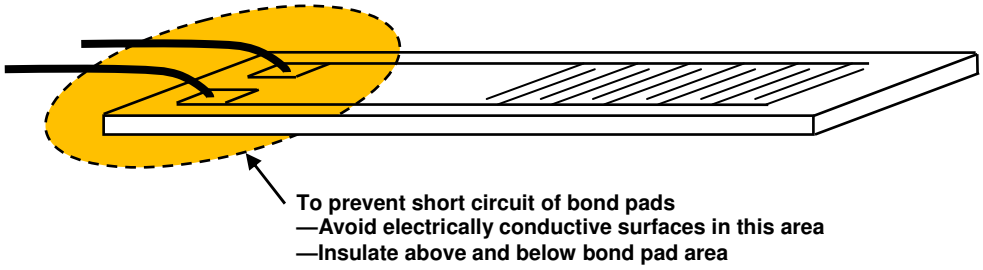

Figure 8-1
Insulating bond pad area

3. To reduce lead capacitance, avoid twisting the leads together; instead, let leads run parallel to each other.

4. Place a sample on the sensor so it has good contact with the electrodes. Cover electrodes completely as shown in Figure 8-2.

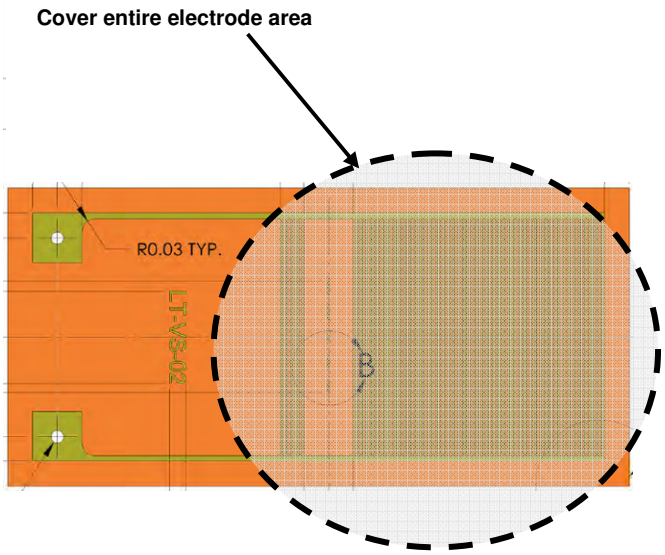

Figure 8-2
Sample application area on sensor

5. Solid samples, or solid samples that melt during processing, require applied pressure.

6. For planar interdigitated electrodes, the thickness of the sample should be greater than the separation between electrodes, otherwise the sensor will also detect air or material on the top side of the sample.

7. To ensure enough resin for good measurements with prepreg, stack at least two or three layers of prepreg on top of a sensor, as shown in Figure 8-3.

8. To prevent shorting of the electrodes, composite materials containing graphite or other conductive fibers require a filter between the sensor and sample, as shown in Figure 8-3.

- Glass cloth with small pore size, fiberglass felt or laboratory filter paper are recommended filter materials.

9. To prevent the sample from adhering to press platens or mold surfaces, use a sheet of aluminum foil above and below the lay-up, as shown in Figure 8-3.

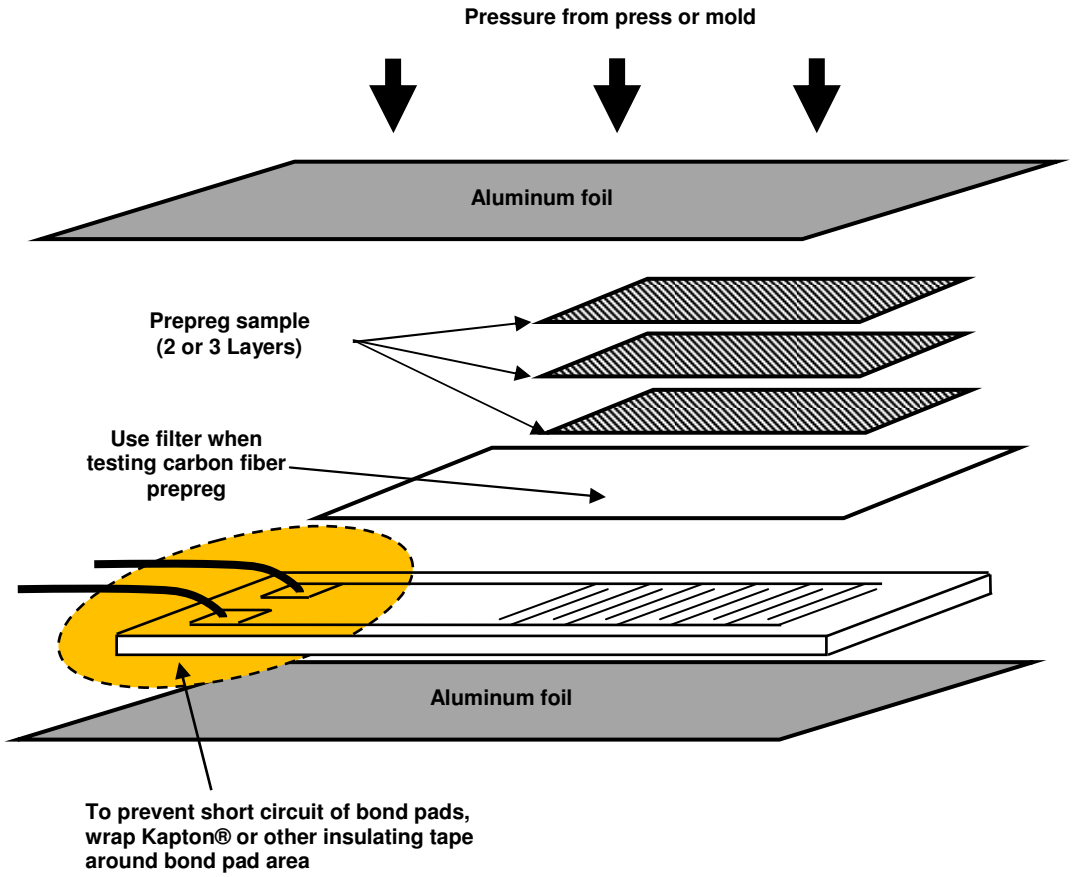

Figure 8-3
Suggested lay-up for prepregs

Reducing noise in leads, extension cables and sensors

Long, unshielded leads can pick up electrical interference and produce noisy data, especially at the end of cure when signal levels are low. For best results, use coaxial cable with shields that are guarded or grounded.

If an instrument measures a response voltage from the dielectric sensor, then a guarded cable is usually more suitable. Figure 8-4 shows a typical configuration for guarded cables. Note that the shields around the leads connect to a x1 amplifier that outputs the guard signal. This guard signal drives the shields with a reproduction of the response, reducing capacitive interaction between the sensitive response line and the outside world.

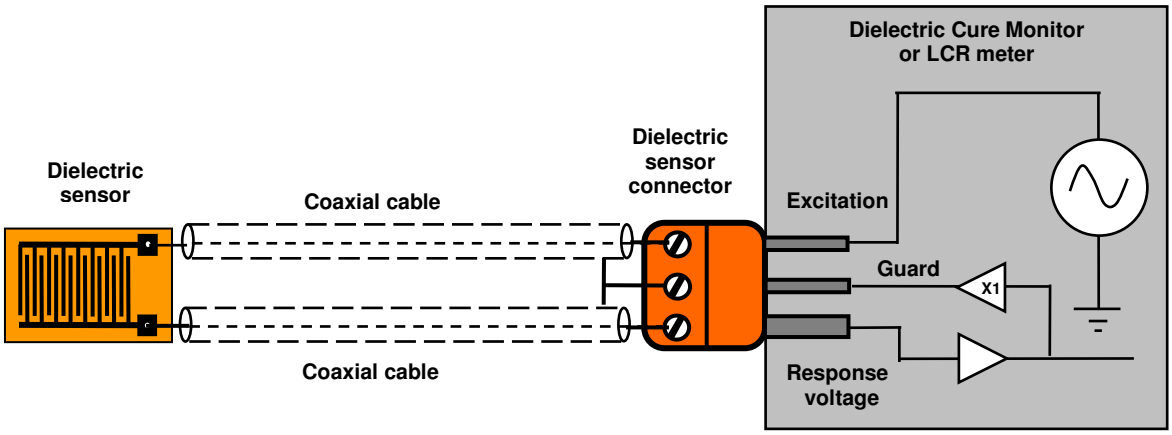

Figure 8-4
Connecting a dielectric sensor using coaxial cable with guarded shields

If an instrument measures a response current from the dielectric sensor, then this current typically goes into a virtual ground. In this case a grounded shield is more suitable, as shown in Figure 8-5.

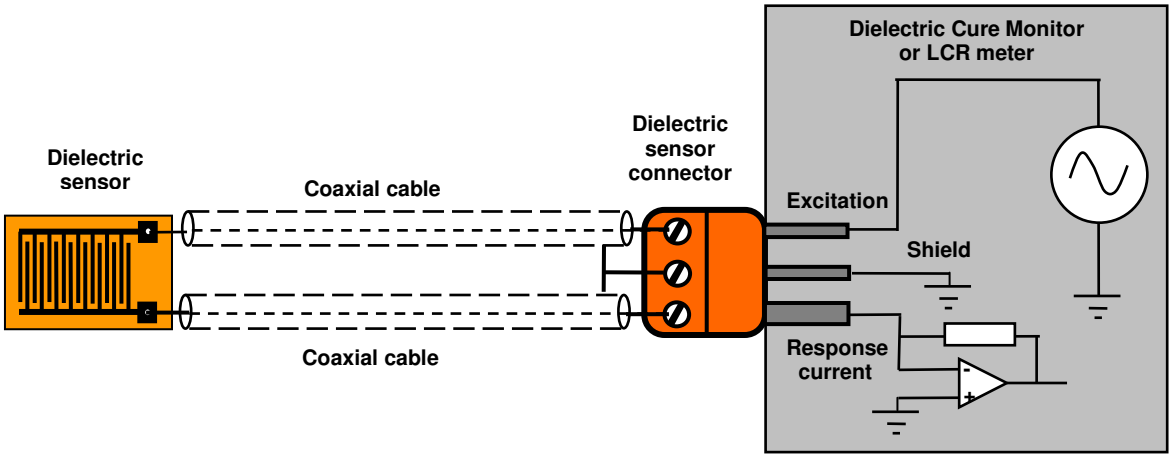

Figure 8-5
Connecting a dielectric sensor using coaxial cable with grounded shields

Even with guarded or shielded leads, the sensor itself picks up electrical noise from the environment. The amplitude of the sensor's voltage signal may be only 10 mV, and the current may be measured in microamps. Nearby power

cords, which can carry 120 VAC or 240 VAC, or ungrounded metal surfaces, which can act as antennas, both are common sources of noise.

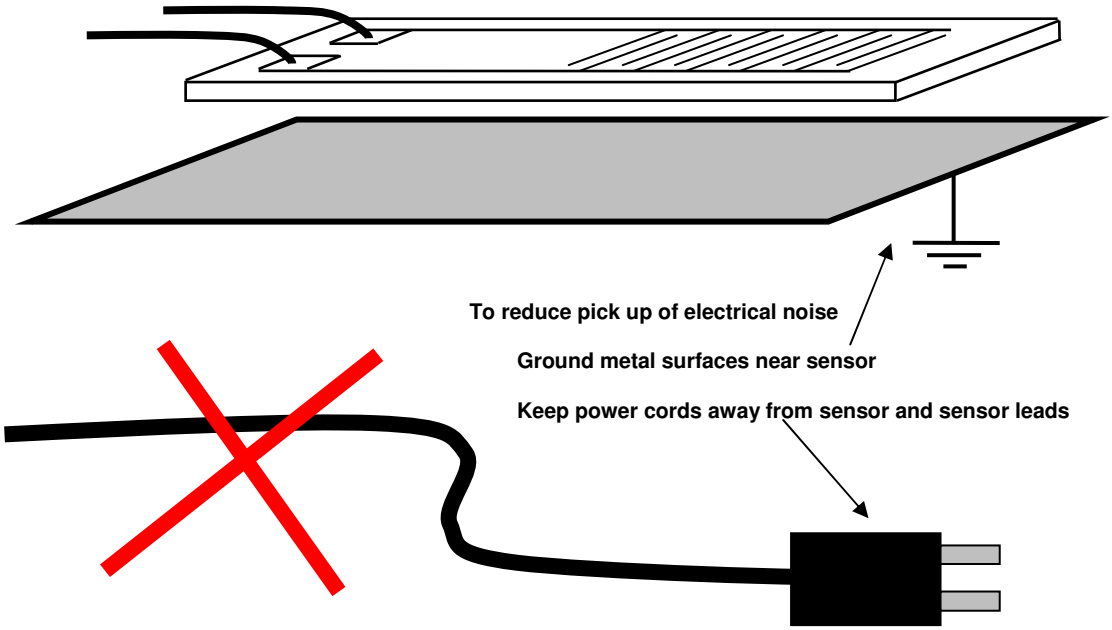

Figure 8-6
Methods to reduce pick up of electrical noise

With proper sample preparation, lay-up and shielding of leads, and attention to the electrical environment it is possible to make good, reproducible measurements of dielectric properties for monitoring the cure of thermoset and composite materials.

Lambient Technologies LLC
649 Massachusetts Avenue, Cambridge, MA 02139
857-242-3963
www.lambient.com
info@lambient.com