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## **Testing Non-linear Materials in the Linkam HFS600 Temperature Stage**

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*Linkam Scientific* in offers unique temperature-controlled stages for electrical testing of samples from -196°C up to 600°C. The HFS600E-P has four internal micromanipulator probes connected to BNC connectors on the side of the chamber. The HFS600E-P stabilizes within 0.1°C of the assigned temperature but can change the sample temperature at a rate up to 150°C/minute or 2.5°C per minute. This high rate of temperature change coupled with the internal electrical connections makes the HFS600 perfect for measuring the pyroelectric coefficient of a sample.

The sample pedestal inside the HFS600 chamber accommodates devices up to 2cm in diameter and is earth grounded. The chamber enclosure will also be earth grounded, making the chamber an efficient Faraday cage that shields the sample from ambient electrical noise. With the sample placed on a passive ceramic insulator atop the stage (supplied by Radiant), the test path is isolated from noise in the earth ground. The ceramic insulator coupled with the Faraday cage effect of the metal enclosure ensures quiet measurements down to very small capacitance values.

The BNC connectors handle up to 300 volts, making it possible to execute all of the electrical measurements of thin ferroelectric and piezoelectric film capacitors allowed by Radiant test instruments over the 600°C to -196°C temperature range. Bulk ceramic or single crystal capacitors may also be tested in this fixture up to 300 volts. This is enough voltage to generate full hysteresis loops on PMN-PT single crystal actuators and to test single layer or multilayer piezoelectric actuators over temperature\*. Pyroelectric characterization of bulk devices is available over the entire temperature range for both thin-film and bulk devices.

The HFS600E-P has a 12.5 millimeter window in its top surface making displacement measurement of the sample with a remote Laser Doppler Vibrometer a possibility. Radiant will evaluate the accuracy of LDV measurement into the HFS600 chamber and release this type of measurement for use by researchers should the necessary precision be maintained over temperature.

The Linkam chamber is already fully integrated with the powerful Vision test and data management system that operates Radiant's test instruments. Once a sample is loaded and a Test Definition is constructed using Set Temperature Task commands to the Linkam T96 controller, Vision will execute the Test Definition for as long as weeks without attendance by the researcher.

*\*High voltage poling of bulk capacitors and piezoelectric actuators above 300 volts will not be allowed inside this chamber. For HV poling up to 650 °C, please acquire a Radiant High Temperature Test Fixture (HTTF) for quartz tube furnaces or box furnaces.*