Dielectric Thermal Analyser (DETA)

Preliminary Information

Triton Technology Ltd are proud to announce the development of a new range of instruments to add to our selection of relaxation equipment. The DS6010 and DS6210 Dielectric Thermal Analysers (DETA) are new twists on established technology. They offer the ability to determine dielectric properties of materials whilst undergoing a temperature or variable humidity program. DETA is ideal for thin film, semisolid or liquid (a Cup Electrode is provided as standard) materials and is also developed for work with powders. The principal use is for looking at relaxation events such as Tg over a large frequency, temperature or relative humidity range. The DS6010 DETA Complete is used for conventional DETA analysis. DS6210 DETA Complete with Humidity Control can be used for conventional analysis or for controlled humidity experiments.

What is DETA?

A sample is placed between two parallel plate electrodes and an alternating current is passed between the two electrodes. Materials possess a dielectric constant ($\varepsilon'$) characterising the extent of electrical polarisation which can be induced in the material by an electrical field. If an alternating electrical field is applied, the polarisation lags behind the field by a phase angle $\delta$. This results in partial dissipation of the stored energy. The dissipated energy is proportional to the dielectric loss ($\varepsilon''$) and the stored energy to the dielectric constant ($\varepsilon'$). $\varepsilon''$ and $\varepsilon'$ are measured by DETA and are comparable to loss and storage modulus measured mechanically by Dynamic Mechanical Analysis (DMA). The ratio of $\varepsilon''/\varepsilon' = \tan \delta$ in the same manner as DMA.

A Dielectric Thermal Analyser (DETA) differs from the more traditional Dielectric Analyser by the design of the instrument to allow reasonable thermal scanning rates on materials. The dielectric properties are used to characterise the relaxation behaviour of the materials in a similar way to DMA.

Two key advantages of DETA are that it is very easy to handle, especially for thin films, and can directly measure the relaxation behaviour at much higher frequencies than DMA.
Outline Specification:

- **Frequency:** 12Hz to 100kHz
  Up to 50 frequencies in same experiment
- **Temperature:** -190°C to 300°C
- **Electrodes:** 10, 33 or 40mm cup
  Parallel plate assembly
- **Electrical:** 5 mV to 1.275V AC
  2V internal DC Bias or 30V external Bias
  200mA max
- **$$\tan\delta$$ res:** > 0.0001
- **Environmental:** Controlled Relative Humidity (Optional)
  Dry purge gas

Example Applications:

The graph on the right shows DETA Tan $$\delta$$ data from a powdered material, Ranitidine HCl, over a short temperature range. Other techniques confirmed the presence of amorphous material in the sample. The peak in the Tan $$\delta$$ data represents the recrystallisation of the amorphous material. The reason for the peak is that on crystallisation, the material releases water which gives an increase in Tan $$\delta$$. As the temperature is increased further, Tan $$\delta$$ decreases as the water is driven out of the sample completely.

The graph on the left shows DETA capacitance and Tan $$\delta$$ data for Nafion at 45°C. The temperature remained constant and the humidity of the environment was increased over time. The initial peak in Tan $$\delta$$ represents the glass transition of this material. Humidity acts to plasticize the material hence allowing the Tg to be crossed isothermally.