

Dielectric Spectroscopy

The relaxational dynamics of soft matter, e.g. polymeric materials and glass-forming liquids, is characterized by a large frequency range. The dielectric (or impedance) spectroscopy, the measurement of dielectric properties, comprises this range. It is based on the interaction of an external field with the electric dipole moment of the sample. The fluctuations of local electrical fields are measured which are connected to the dynamics on a molecular scale.

Because the frequency range of neutron scattering is rather limited, but on the other hand neutron scattering supplies spatial information, which is not obtainable by dielectric spectroscopy, both methods are complementary.

The apparatus is employed in different fields, e.g.

- for the measurement of relaxations in glass-forming systems whose characteristic times are spread over many orders of magnitude and are often strongly temperature dependent in addition,
- for measurements of the dynamic (AC) conductivity of polymeric ion conductors
- for the determination of the influence of plasticizers on the relaxational properties of polymers, where a central problem is the suppression of secondary relaxations which can be observed by impedance spectroscopy,
- for measurements on mesoscopically confined glass-forming systems in order to study the influence of system size on the dynamics of glass-formers.

An Alpha high resolution dielectric analyzer with a broadband dielectric converter constructed by *novocontrol* can be used to measure the impedance or complex dielectric function in a frequency range from 3 μHz through 10 MHz. The temperature range is between -170°C and $+400^\circ\text{C}$, the resolution limit lies at $\tan\delta < 10^{-4}$.

The high frequency range from 1 MHz to 1.8 GHz is covered by a HP 4291 A impedance analyzer made by *Hewlett Packard*. Here, the resolution is $\tan\delta \approx 10^{-2}$.

Alpha High Resolution Dielectric Analyzer	
Frequency range	3 μHz to 10 MHz
Resolution	$\tan \delta < 10^{-4}$
Temperature range	-170°C to $+400^\circ\text{C}$
HP 4291 A	
Frequency range	1 MHz to 1.8 GHz
Resolution	$\tan \delta \approx 10^{-2}$
Temperature range	-170°C to $+400^\circ\text{C}$



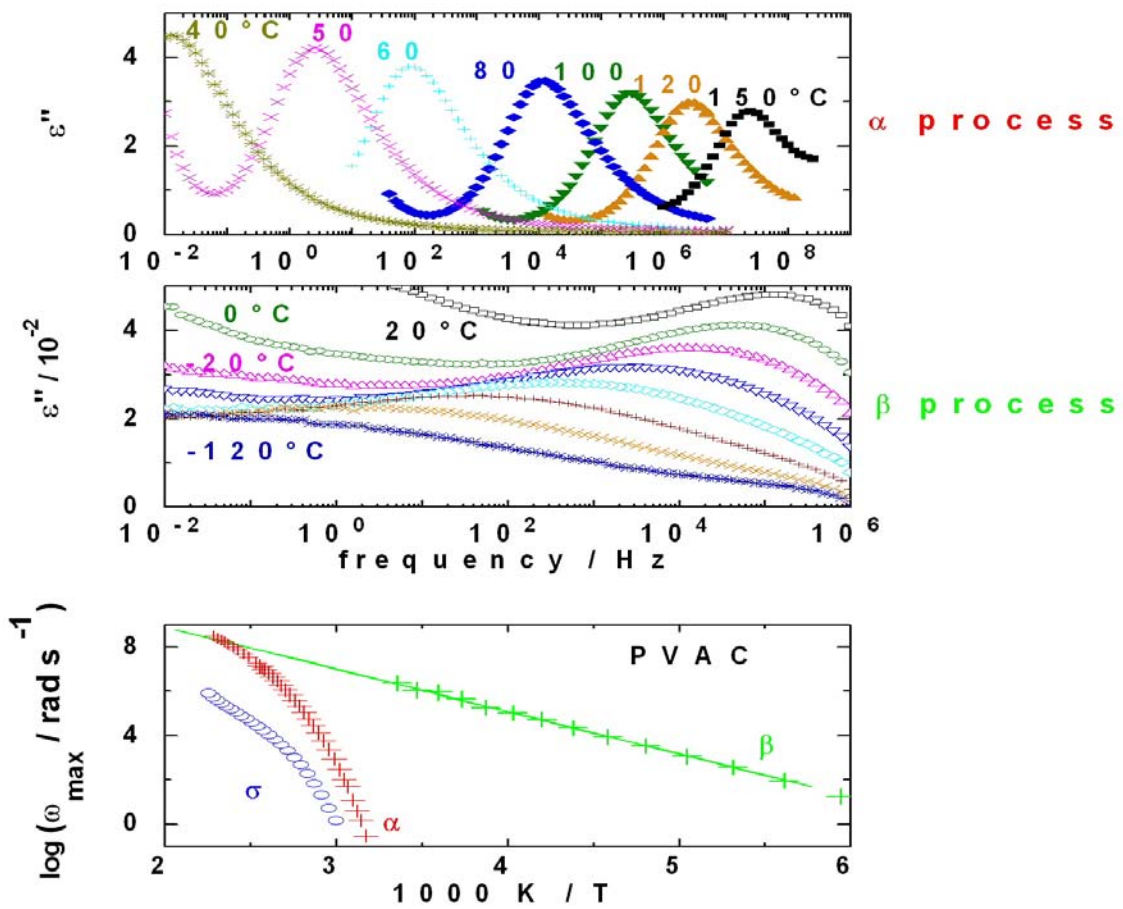
Dielectric spectrometer
novocontrol
(high frequency device)



High frequency sample holder



Low frequency sample holder



Typical experimental results from a polymer sample