P-PMP4: Broadband dielectric resonance spectroscopy on ferroelectric and cellular ferroelectric polymers

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Dielectric spectroscopy is not only a versatile tool for the study of conduction and molecular relaxation processes, it also provides a means for the electrical measurement of acoustical, mechanical and electromechanical tensor elements of piezoelectric materials. Such measurements are based on the analysis of piezoelectric resonances. Unlike molecular relaxation peaks, where the full width at half maximum of the loss peak is at least one decade, resonance peaks are much narrower. Therefore, the frequency resolution of the measurements must be increased around the resonance peaks. Depending on the mechanical and piezoelectrical tensor elements under investigation, different electrode geometries must be used.

For ferroelectric polymers, piezoelectric resonances are superimposed on a broad dielectric relaxation process. Therefore, it is essential to employ broadband dielectric relaxation and resonance spectroscopy in correctly analyzing the piezoelectric resonances. The technique is well suited for discriminating between uniaxially or biaxially stretched ferroelectric polymers from simple electrical measurements.

Cellular ferroelectric polymers are essentially based on nonpolar polymers, therefore the dielectric function shows practically no dispersion over a wide range of frequencies. Ferroelectric polymers exhibit strong piezoelectric properties after internally charging the voids of the material. The piezoelectric resonances in ferroelectrets are therefore easily detected, since they are not superimposed on broad molecular relaxation processes. Here we show that the geometrical form of the voids within the cellular polymer is directly reflected in the strongly anisotropic mechanical and electromechanical properties of cellular polymers, thereby paving the way for tailoring material properties of cellular polymers.

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