# MEASUREMENT OF THE ISOTHERMAL AND ADIABATIC DIELECTRIC CONSTANT OF TGS

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## ABSTRACT

With a digital realization of a lock-in amplifier, measurements of the dielectric constant can be performed down to frequencies of $10^{-3}$Hz. The dielectric constant is usually measured at frequencies above the thermal relaxation frequency, thus realizing adiabatic conditions. However, the digital lock-in amplifier allows measurements at frequencies below the thermal relaxation frequency too, thus realizing isothermal conditions. To separate the influence of domain and conductivity effects, the thermal time constant of the sample has been varied. Spectra of the dielectric constant are measured with variable coupling of the sample to a heat sink of liquid paraffine. The influence of the entropic contribution to the dielectric constant is directly gained from these spectra.

## 1. INTRODUCTION

Under common experimental conditions, the frequencies for the measurement of the dielectric constant are much higher than the reciprocal thermal relaxation time constant of the sample. In this way, the adiabatic dielectric constant $\epsilon^S$ is measured, while the isothermal dielectric constant $\epsilon^T$ can only be calculated with the additional knowledge of the pyroelectric coefficient $p$ and the specific heat $c$ of the material [1]:

$$\epsilon^T = \epsilon^S + \frac{p^2 T}{c} \tag{1}$$

In this work an experimental method for a direct measurement of $\epsilon^T$ is presented.

## 2. THEORY

Heat exchange with the surroundings at low frequencies, i.e. constant temperature of the sample, and adiabatic isolation of the sample at high frequencies, i.e. constant entropy, leads to a frequency dependence of the dielectric constant $\epsilon(f)$, which is given by:

$$\epsilon(f) = \epsilon^S + \frac{\epsilon^T - \epsilon^S}{1 + if/f_{th}} \tag{2}$$

$f_{th}$ is the thermal relaxation frequency of the sample, determined by its heat capacity and the heat loss to the surroundings.