PROTOCOL 6/2018
Dielectric absorption tests at room temperature
in the frequency range from 10^{-1} Hz to 10^{7} Hz
for the Composite Adhesive Matrix, ADR Technology

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1. Aim of the research: determination of the dielectric absorption window for various ADR Technology Adhesives / Matrixes in the frequency range of 10^{-1} Hz - 10^{7} Hz at room temperature. The ADR Technology samples were provided by Stanisław Wosiński.

2. Method of measurement: the dielectric is characterized by a relative complex permittivity:

$$\varepsilon^* = \varepsilon' - j\varepsilon'', \tag{1}$$

where "relative" means normalization against the in vacuo dielectric constant ε_0 = 8.85×10^{-12} F/m.

$$\varepsilon'' = \varepsilon_p'' + \frac{\sigma_{dc}}{\varepsilon_0 f}, \tag{2}$$

are the sum of losses associated with dielectric polarization ε_p'' and ohmic loss $\sigma_{dc}/\varepsilon_0 f$ (σ_{dc} means DC conductivity, f is the frequency of the measuring field). Both electric permeability ε* as well as the tangent of the dielectric loss angle

$$\tan\delta = \frac{\varepsilon''}{\varepsilon'} = \frac{\left(\varepsilon''_p + \frac{\sigma_{dc}}{\varepsilon_0 f}\right)}{\varepsilon'} \tag{3}$$

they depend on the frequency of the measuring field. In the frequency range *f* from 1×10^{-1} Hz do 1×10^{7} Hz, dielectric properties are measured in a system in which the sample fills the measuring capacitor (a flat condenser).

3. The apparatus and experiment of the dielectric response of the sample were tested using the Alpha-A High Performance Frequency Analyzer (Novocontrol GmbH). The sample was a Composite filled flat condenser with a diameter of 20 mm and a thickness of 0.13 – 0.36 mm, placed at room temperature (293 K). Impedance *Z'* (od 10^{-3} Ω do 10^{15} Ω), Capacity *C* (10^{-15} F do 1 F) and the tangent of the dielectric loss angle $tan\delta$ measured over a period of 8 decades of frequency (1×10^{-1} Hz do 1×10^{7} Hz) at a sampling voltage of 1V. The real part of the electrical permittivity ε' samples were calculated from the dependence:

$$\varepsilon' = \frac{d}{\varepsilon_0 S} C, \tag{4}$$

where *d* - means the thickness of the sample (w m), *S* is the surface of the sample (w m2), *C* – its capacity (w F) and a ε_0 = 8.85×10^{-12} F/m) is the dielectric constant of the vacuum. The imaginary part ε'' of the complex permittivity of the sample is:

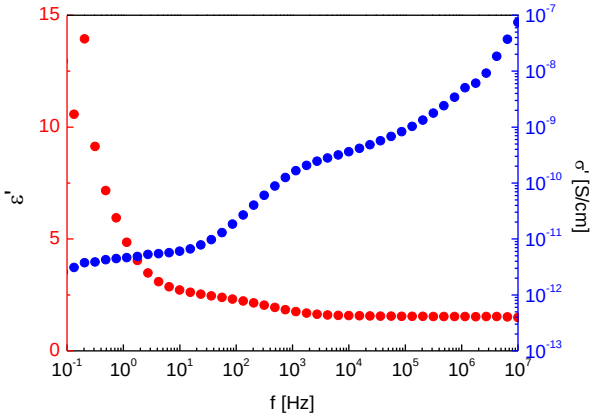
$$\varepsilon'' = \varepsilon' \tan \delta. \tag{5}$$

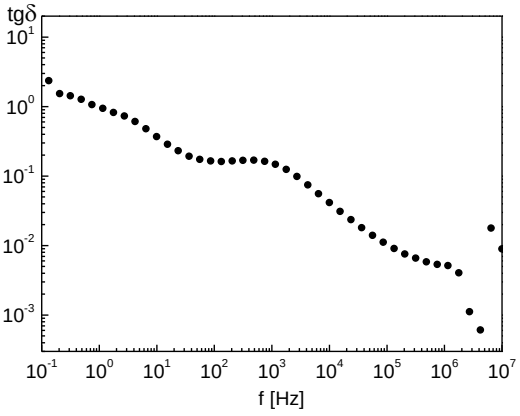
The measured values were stored in memory and the sample characterizing quantities were calculated using WinDETA impedance analysis software and the WinFit V 3.2. Program.

4. Results. Four series of dielectric measurements (3 measurements) were carried out for each ADR Technology sample.

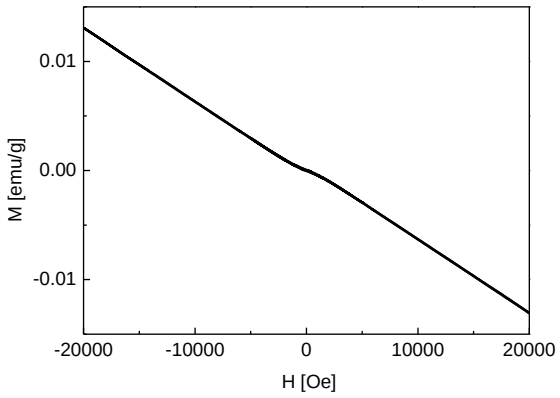
Series I - Composite Glue / Matrix 1

The measurements were made in an open space with a relative humidity of ~ 20% at room temperature (293 K) for the sample provided by ADR Technology. The results presented are the average of 3 measurements. In addition to ADR technology, the sample was: Saltadis adhesive and Lenko S.A. foil.



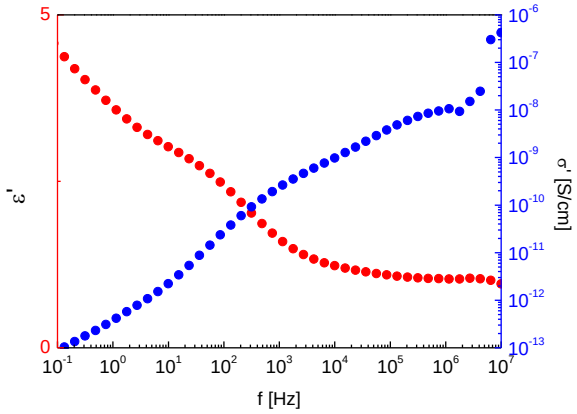


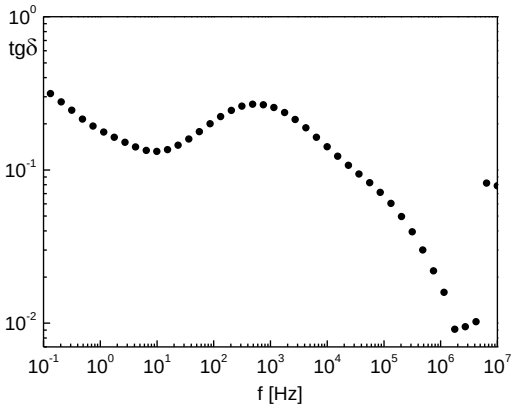
For **Series I**, a magnetic hysteresis loop measurement was also carried out at room temperature. The material tested has diamagnetic properties.



Series II - Composite Glue / Matrix 2

The measurements were made in an open space with a relative humidity of ~ 20% at room temperature (293 K) for the sample provided by ADR Technology. The results presented are the average of 3 measurements. In addition to ADR technology, the was a sample of Saltadis adhesive.

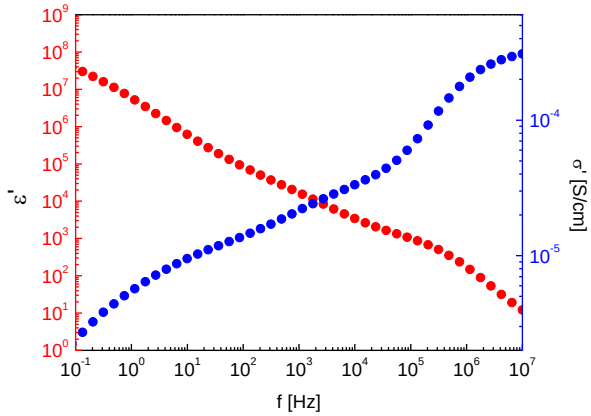


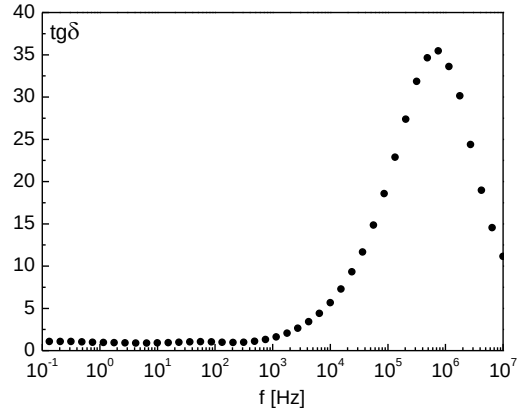


Series III / IV Composite Glue / Matrix 3

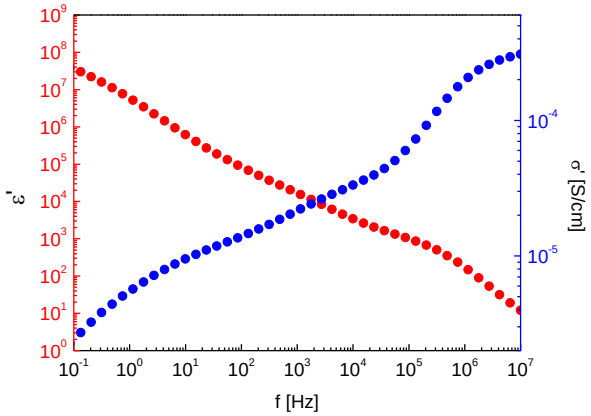
The measurements were made in an open space with a relative humidity of ~ 20% at room temperature (293 K) for the sample provided by ADR Technology. In addition to ADR technology, the was a sample of Saltadis adhesive. Series III and IV were made within 30 minutes. The first measurement of each series differs from the others in both cases.

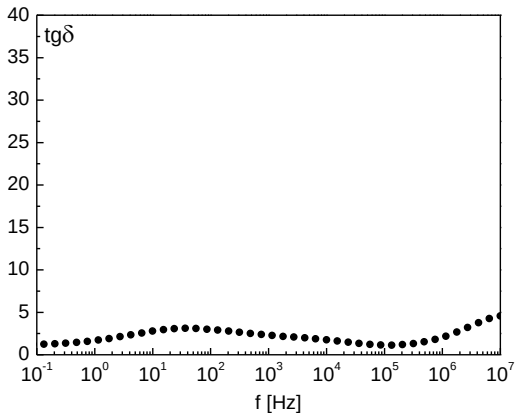
Series III - measurement 1



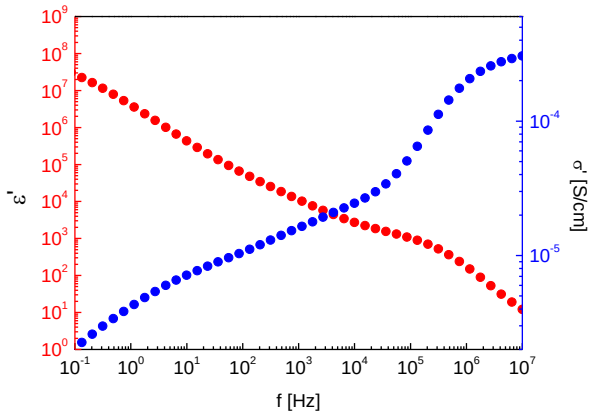


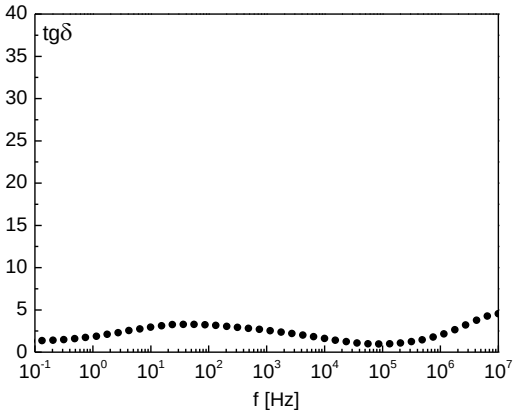
Series III –Measurement 2



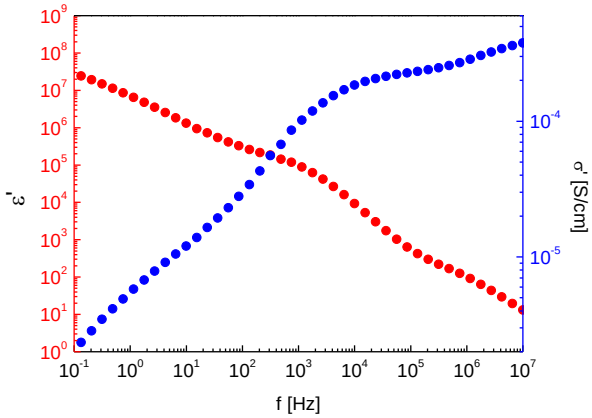


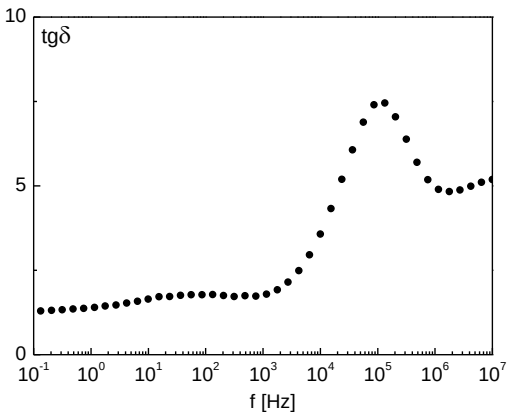
Seria III – Measurement 3



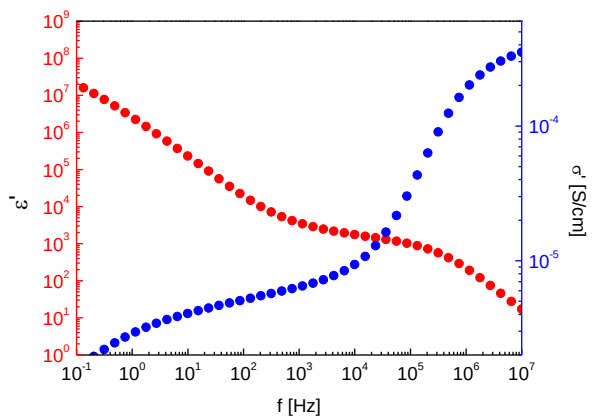


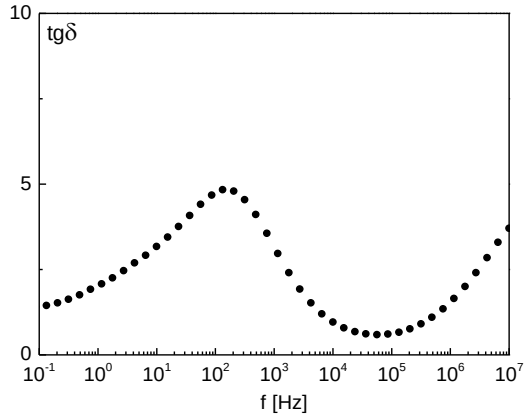
Series IV –measurement 1



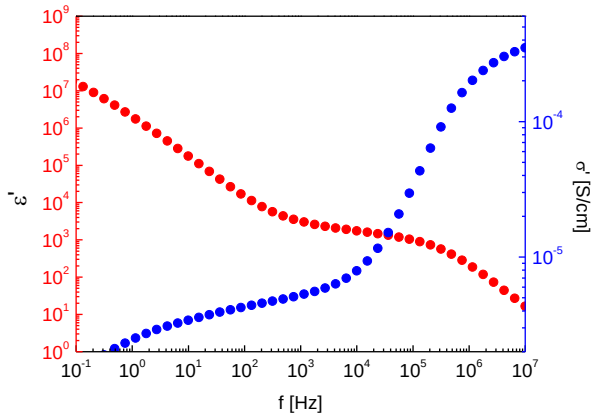


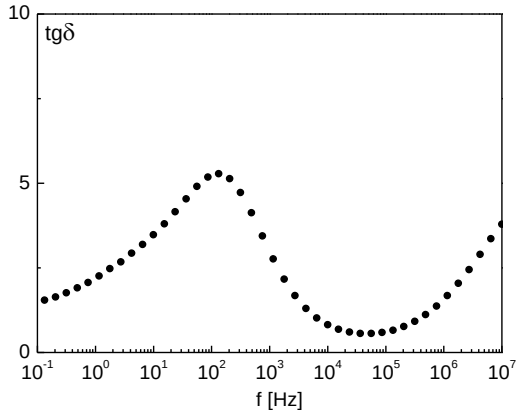
Series IV –measurement 2





Series IV –measurement 3





5. Summary

i) The Saltadis adhesive with ADR technology placed between metal electrodes (Series III and IV) has dielectric properties suitable for EMF shielding in the whole frequency range of 0.1 Hz – 10 MHz. Measurements, however, indicate that it was measured in a non-stabilized state (non-aging).

ii) Saltadis adhesive composites with ADR technology and foil from Lenko exhibit very low ε' values and low dielectric losses. Due to the dielectric properties of the adhesive, we suggest re-measuring this system with other electrodes.

iii) Saltadis adhesive composites with ADR technology and foil from Lenko have diamagnetic properties.

iv) We believe that both the adhesive and the entire system require research on the stabilization process (aging).