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The justified data-curve fitting approach: Recognition of the new type of kinetic equations in fractional derivatives from analysis of raw dielectric data

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Abstract

Usually, for the description of dielectric spectra one uses the empirical Cole-Davidson (CD) and Havriliak-Negami (HN) equations each of which contains one relaxation time. However, the parameters figuring in the CD and HN equations (or the linear combination of several CD or HN equations) do not have any clear physical meaning. For the description of such asymmetric dielectric spectra, we suggest complex permittivity functions containing two or more characteristic relaxation times. These complex susceptibility functions correspond, in the time-domain, to a new type of kinetic equation, which contains non-integer (fractional) integrals and derivatives. The physical meaning of these operators is discussed in [1]. We suppose that these kinetic equations describe a wide class of dielectric relaxation phenomena taking place in heterogeneous substances. To support and justify this statement, a special recognition procedure has been developed that helps to identify this new kinetic equation from real dielectric data. This recognition procedure can be considered as the justified data-curve fitting (JDCF) approach, in contrast to the conventional 'imposed' data-curve fitting (IDCF) treatment invariably used in modern dielectric spectroscopy. The JDCF approach incorporates the ratio presentation (RP) format and a separation procedure. It is shown how this separation procedure can be helpful in the detection of the many relaxation processes (each process is described by a characteristic relaxation time), which are taking place in the dielectric material under consideration.

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