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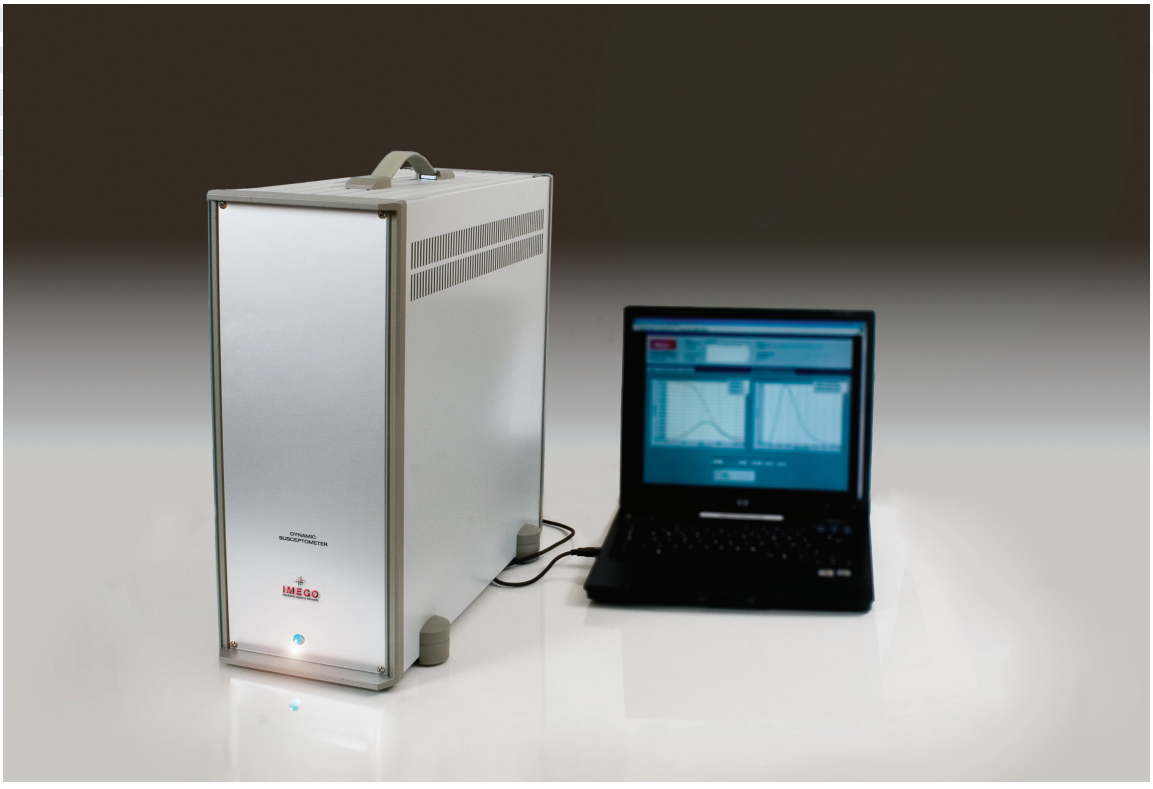
DynoMag ®

The unique AC susceptometer



Imego have developed a unique portable AC susceptometer with the largest frequency range compared to other commercial AC susceptometers. With the instrument it is possible to measure on liquids, powders or solid samples.

The frequency range is from 1 Hz up to 200 kHz with a resolution in magnetic moment of $3 \cdot 10^{-11}$ Am^2 or in volume susceptibility $4 \cdot 10^{-7}$ (SI-units) at 1 kHz and excitation amplitude of 0.5 mT. With the software it is possible to set measurement parameter, visualize the data, store the data, calibrate the instrument, perform data fittings of the result and to determine the hydrodynamic size of particles that undergo Brownian relaxation (particle rotation).

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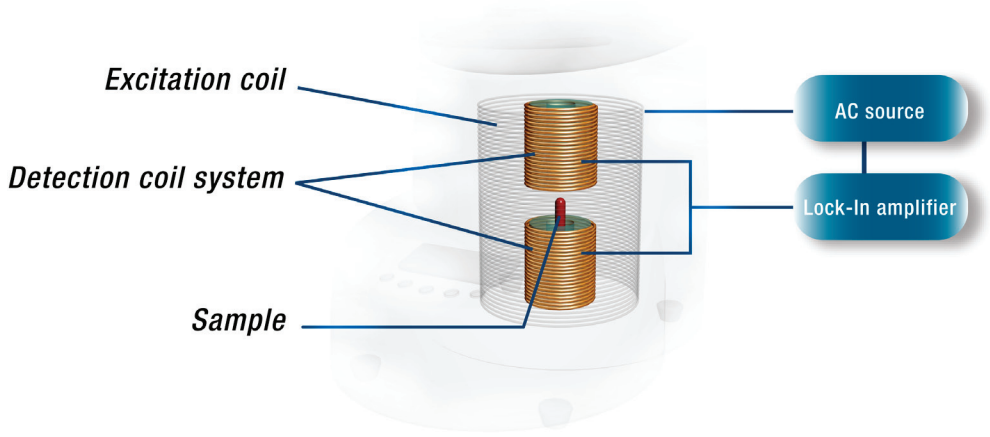
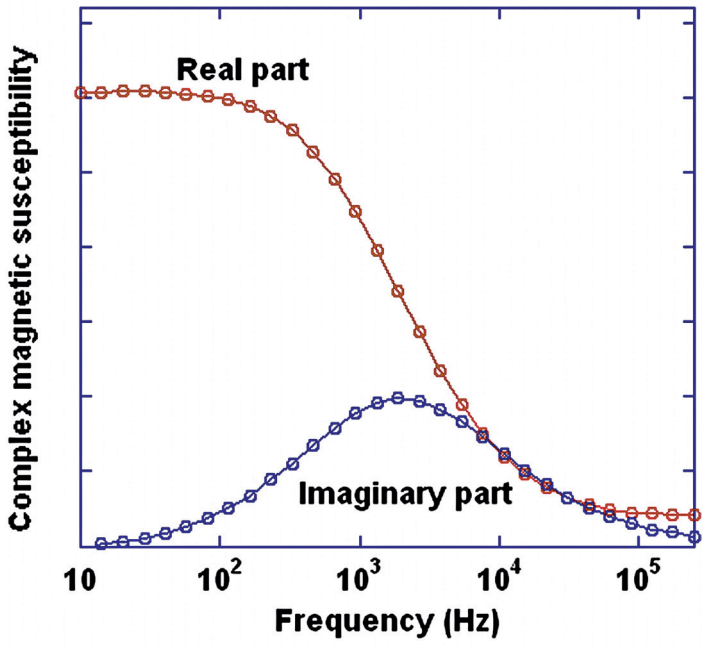


The software of the system governs the whole experiment, for instance optimum measurement time settings (automatically adjusted in the system), automatically adjusted gain settings to the amplifier, frequency range, number of data points etc. and the collection of the data and presentation of the result in a user friendly interface. In the system there is also a calibration procedure that is performed in the whole frequency range from a few Hz up to 200 kHz. The calibration procedure is carried out with a paramagnetic substance. The sample holder is a cylindrical glass tube and the sample space volume is up to 0.2 cm^3 (sample volumes can be customized).

Induction technique is used to measure the AC susceptibility. The magnetic flux change due to the sample in the detection coil system is detected with a well balanced detection coil system. The detection coil system is centred in an excitation coil system connected to an AC - source that delivers the time dependent current to the excitation coil that gives the magnetic excitation field. The signals from the detection coil system are fed into a low noise Lock-In amplifier. All the electronics are integrated in the instrument.

The instrument determines the real part of the complex susceptibility (in phase component) and the imaginary part (the loss term) versus frequency of the excitation field. The susceptibility is given in SI units as volume susceptibility for liquid samples and mass susceptibility for powder samples.

Dynamic magnetic properties give information on the rate of how the magnetization is building up in the material. Different types of magnetization processes, for instance magnetization reversal in magnetic singledomains (Néel relaxation), randomly rotation of particles containing thermally blocked



The figure shows a result from a maesurement using the DynoMag instrument. The figure displays the real and imaginary part of the complex susceptibility versus frequency for magnetic nanoparticles of cobolt-ferrite dispersed in a liquid. The decrease in real part and the maximum in imaginary part of the susceptibility at about 2 kHz are due to Brownian relaxation of the nanoparticles

singledomains (Brownian relaxation) or domain wall motions as in polydomain materials can be detected with dynamic magnetic measurements. All of these magnetization processes create a specific pattern in the dynamic magnetic properties. In a magnetic particle system the magnetic susceptibility at low magnetic fields is sensitive to the size of the magnetic single domains, the number of magnetic single domains per particle, the configuration of the magnetic single domains in the total particle, the material in the single domains, the concentration of the magnetic single domains and also on the total particle size (when the particle includes singledomains with slow internal relaxations). This makes AC susceptometry a very good parameter in order to have a good control of the manufacturing process of magnetic particle system.

Using this instrument it is also possible to qualitativelly study clustering process of the particles and to follow the binding reactions of different substances to the surface of the particles.

We offer additional software packages. The software packages can be used to determine the hydrodynamic size distribution of magnetic particles that undergo Brownian relaxation which can be used as a sensitive immunoassay for various analytes or to magnetically characterize a magnetic nanoparticle system. The instrument also gives a possibility to determine magnetic remanence of a magnetic nanoparticle system.

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DynoMag specification

Property	Value	Comments
Frequency interval	1 Hz – 200 kHz	Accuracy in magnetic moment is lower below 5 Hz
Amplitude of excitation field	0.5 mT = 5 G	The magnetic field strength is constant below 1 kHz, falling off at higher frequencies
Volume susceptibility resolution (SI units)	$4 \cdot 10^{-7}$	Standard deviation of the volume susceptibility, measured at 1 kHz, with an excitation filed of 0.5 mT and a time constant of 1 s.
Sample size	Cylindrical sample holder with volume 0.2 cm^3	The sample volume can be customized to smaller volumes than 0.2 cm^3.

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