NanoKit

- Broadband Dielectric Spectroscopy on nanometer thin molecular layers
- Suppression of artefacts — evaporation of counter-electrodes no longer required
- Nanostructured electrode arrangements with SiO₂ spacers
- Includes dedicated sample holder to position and contact the nanostructured electrodes, fitting into the Novocontrol standard sample holders BDS 1200 and ZGS (Alpha-A Active Sample Cell)
- Sample holder allows easy operation within several Novocontrol temperature control environments (Quatro Cryosystem, Novocool Cryosystem, Novootherm)
- Additional tools included (vacuum tweezers etc.)

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Introduction

A particular feature of the dielectric measurement technique is its increase in sensitivity with decreasing thickness of the sample capacitor, i.e., less material yields stronger signals.

For nanometric or even submolecular layers of molecules in a capacitor-like arrangement, this unique principal advantage, however, can be exploited only if the technological challenge of reproducibly applying an electric field in a well-defined geometry is adequately solved.

Evidently, the conventional approach, i.e., the direct evaporation of a metal counter electrode on the molecules under study, is no longer feasible due to its high probability of producing electric shorts.

The Novocontrol Technologies NanoKit opens a novel avenue to the study of molecular relaxations and charge transport on nanometric length scales even down to layers of isolated molecules anchored to a surface.

- ultra-flat highly conductive Si wafers
- thin organic layer (3 nm)
- 60 nm spacers = silica nanostructures

To this end, the NanoKit uses nanostructured electrode arrangements of highly insulating SiO$_2$ spacers with typical heights of 60 nm. Highly doped ($ho$=0.002 $\Omega$cm) Si dice, cut out of ultrat-flat wafers with an rms roughness of about 0.5 nm, are used as electrodes.

The molecules under study are deposited on the substrate (plane die) either by spin coating or by Dip-Pen-Nanolithography. The sample capacitor is completed by covering the plane die which carries the sample by the upper die which is equipped with nanostructured insulating spacers.

Evidently preparations of this kind require appropriate conditions provided by, e.g., clean rooms or clean benches. Since the surface-to-volume ratio in nanometric samples is extraordinarily high, effects due to the adsorption of, e.g., water or organic pollutants from ambient air must be considered with great care.

The Novocontrol NanoKit offers the essential parts for a straightforward start into the preparation of nanometric thin film samples appropriate for dielectric measurements. Details of preparation are described thoroughly, rendering your sample preparations and measurements a straightforward procedure.

NanoKit Content

- various sets of dice covered with nanostructures of different heights
- different cell geometries according to the particular thickness of the sample
- sample holder specifically designed for measurements with nanostructured electrodes
- equipment for handling and cleaning the dice.

Operation Requirements

- Preparations of capacitors of thicknesses down to 60 nm require cleanroom conditions or at least a flow box with filtered air.
- Filters of grade H14 recommended (>99.995% of dust particles removed).

Commercial systems are offered, e.g., by
- spe tec Ges. für Labor und Reinraumtechnik mbH (www.spetec.de)
- Bleymehl Reinraumtechnik GmbH (www.bleymehl.com)
- erlab D.F.S.S.A.S (http://capair.com)

Conclusion

Measuring the dielectric properties of materials on nanometric length scales requires particular attention to sample preparation. Due to incomplete surface coverage, applying metal electrodes to ultra-thin film samples by sputtering or evaporation frequently leads to shorts. Line broadening in dielectric loss spectra of, e.g., thin polystyrene layers with decreasing dimensions appears in samples with evaporated electrodes only. Samples equipped with nanostructured electrodes do not show any such effect.

The Novocontrol NanoKit offers all essential parts to perform dielectric measurements on ultrathin film samples. Nanostructured electrodes, sample holders, and further accessories of the Novocontrol NanoKit are seamlessly integrated into the Novocontrol system of sample cells and dielectric spectrometers.

References