Abstracts of IGC Symposium 2019

Characterization of Composite Materials at Microscopic levels and its Macroscopic Properties

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The assessment of the utilitarian properties of the composites in the macroscopic scale is expensive and time consuming. It is necessary to make the model preliminary products that is cost and time consuming. Moreover, the macroscopic tests do not explain the reason of the observed phenomena which is the first step in order to improve the quality of the product, solve some technological problems during it fabrication. Thus, the need of studying microscopic phenomena in the industry is crucial. The applied methods should be quick, accurate and relatively cheap and reflect the properties of the raw materials, semi-product and product in the real condition. One of such technique fulfils aforementioned circumstances is Inverse Gas Chromatography (IGC). The authors of this presentation show the way of the using IGC parameters for assessment of some aspects important in industry from technological point of view. This technique was successfully used for studying e. g. aging of the phenolic resins, the well-known binder material [1-2]. Moreover, it was used for prediction of the homogeneity of the filler in the polymers matrix and it was correlated with the results of Dynamic Mechanical Thermal Analysis (DMTA) [3-4].

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Inverse gas chromatography studies of modified glass particles with different morphologies

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The separation of fine particles is a challenging task where a proper understanding of the interfacial properties is crucial. In our research, we focus on flotation, which is a powerful and widely used separation technique, where valuable mineral particles are selectively separated from unwanted gangue, with particles in the size range of about 10 µm to 200 µm. For this process, particle properties such as wettability, size or morphology are fundamental separation features.

Although, it is a well-established processing technique that is used all over the world in industry, there are still some challenges with regard to the processing of ultrafine particles with sizes below 10 µm. The aim of this project, which is part of the German research foundation priority programme DFG-SPP 2045 “MehrDimPart”, is to gain a deeper understanding of the microprocesses that occur during flotation and to have a closer look on the influence of particle properties, like wettability and morphology.

For this research glass particles are used as their surface chemistry can be modified in different ways. Here, the functionalisation was carried out by esterification with alcohols, where the wettability of the product can be controlled by the length of the alkyl chain. In order to investigate the effect of particle morphology on flotation three differently shaped glass particles were used and esterified, including fibres, spheres and fragments with differing shapes. Inverse gas chromatography is used to characterise the particles surface energy distributions, which provide information about the particles wettability as well as the heterogeneity of the surface.

Temperature effect on acid-base properties of solid materials by IGC at infinite dilution

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Inverse gas chromatography technique at infinite dilution was used to study the temperature effect on the acidic and basic surface characteristics of some solid substrates like oxides MgO, ZnO, SiO2 and Al2O3, carbon fibres, cellulose acrylate and polymers as poly (α-n-alkyl methyl methacrylate). We determined the specific interactions between them and model organic molecules and showed the amphoteric feature of such solids. We proved that the usual relation giving the specific enthalpy of adsorption (ΔHsp) of a polar molecule adsorbed on a solid:

$(-\Delta Hsp) = (KA\ DN + KD\ AN)$

was not correct for oxides and carbon fibres. We proposed a new relationship by adding a third parameter K reflecting the amphoteric character of the solid according to :

$(-\Delta Hsp) = KA.DN + KD.AN – K.\ AN.DN = w(KA\ DN + KD\ AN)$

where w is the weighing factor of the exchanging interactions between adsorbed molecule and solid substrate. These surface variables of used polymers and cellulose acrylate were proved to be strongly dependent on the temperature. One proves that the specific enthalpy and entropy of interaction of polar probes are functions of the temperature The application of Hamieh's model allows to the determination of the acid base constants KA and KD and the amphoteric constant K of polymer and cellulose acrylate surfaces. It was proved that the constants KA, KD and K of such materials strongly depend on the temperature. This study allows us to determine the

probability w of the specific adsorption of polar probes on the solid surfaces. This probability parameter also depends on the temperature.

IGC studies on acid-base properties of polymers and silica materials

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The acid-base surface properties of polymers and silica materials have been determined by IGC measurements with polar probe molecules using the Infinite Dilution mode. Based on the specific part of the free energy of adsorption, the acidity/basicity parameters according to the GUTMANN approach were calculated using known acceptor and donor numbers of the injected probe molecules.

In addition, Lewis acid-base surface characteristics according to the VAN OSS approach have been determined for PVC and porous glass. Because of the nonlinearity of the VAN OSS approach, the surface energy values were typically estimated using appropriate pairs of exclusively monopolar probe molecules such as ethylacetate-dichloromethane or toluene-chloroform. In contrast, we analyze the IGC data of both monopolar and amphoteric probe molecules simultaneously. Using a least-square procedure allows to perform the / calculation even for amphoteric probe molecules such as methanol and ethanol. Thus, both the acid-base surface characteristics as well as the specific component of the surface energy have been obtained.

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