SYNTHESIS AND FUNCTIONALIZATION OF SUPERPARAMAGNETIC NANOPARTICLES FOR NEW POLYMERIC MATERIALS

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Magnetic particles are widely studied for their applications in various fields in chemistry, biology and medicine. One application of scientific and technological interest is the use of composite materials like ferrofluides or magnetic rubbers as adjustable dampers. The damping properties of such a material can be varied by an external magnetic field.
In this text the synthesis, functionalization and analysis of magnetite nanoparticles with superparamagnetic properties and the synthesis of composite materials is presented.

Introduction

In this work magnetite nanoparticles were prepared with a diameter about 15 nm, which are coated with silica or a near monolayer of silanes with organic groups like acrylate or vinyl. The particles are incorporated as a superparamagnetic filler in PMMA and butadiene rubber (BR) to get organic-inorganic hybrid materials. These nano composites are characterized by using FT-IR-spectroscopy, thermal analysis (TGA / DSC), TEM, XRD and DLS.
In a second part, the magnetite nanoparticles are dispersed in various solved polymers and used in an electrospinning process. The received hybrid nano fibres can be used as a filler for different rubbers.

Experimental

Magnetite particles are prepared by the usual co-precipitation method, adding 5 mol/l NaOH solution into the mixed solutions of $FeCl_2$ (0.25 mol/l) and $FeCl_3$ (0.5 mol/l) with a molar ratio of 1:2. The NaOH solution is slowly added drop wise under rapid stirring up to pH 11 at room temperature. The slurry is washed by magnetic separation up to pH 7.
After drying at room temperature in vacuum, the particles are dispersed in ethanol and mixed with TEOS (tetraethyl ortho silicate) or a silane (1 g / g particles) and functionalized at room temperature for 24 hours.
With a methacrylic acid silane functionalized particles are dispersed in THF and MMA, then the mixture is polymerized and cleaned. A TEM image of the product is shown in figure 1.
The particles are dispersed in solved BR and after drying the mixture is vulcanized and characterized using TEM and TGA.

Results and Discussion

The diameter of the dry magnetite particles is determined by TEM image to 9 - 17 nm. The diameter in ethanol is about 1.66 µm due to agglomeration.
After functionalization with TEOS the diameter in ethanol is about 144 nm. This shows a better separation of the core-shell particles.
The TGA measurements show that the acrylate functionalized particles have about 1.5 wt% organic groups on the surface. At 192 °C the magnetite oxidizes to magnesite. This is shown as well by a changing of the particle color from black to red.

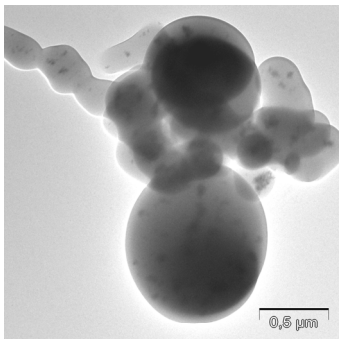

Figure 1 - TEM image of magnetite nanoparticles in PMMA.

References

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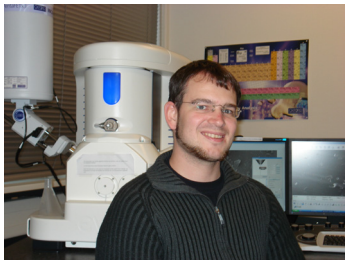

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- Funktionelle anorganische Füllstoffe
- Nanomaterialien
- REM, TEM