Functional materials with nano-micro sized internal structure for biomedical applications

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Aim of the presented research is to show an effective method to obtain functional materials having mechanic stability, biocompatibility and presence of functional groups with an internal porous-interconnected structure.

In particular, a specific technique to obtain such materials is presented. We focused our attention on the High Internal Phase Emulsion (HIPE) method which provides an emulsion with not less than 80 % of internal phase. HIPE method allows to polymerize monomers (and crosslink them) in both internal or external phase of the emulsion. Depending from the physical localization of the monomer(s), one could obtain a porous monolithic structure (if the monomer(s) is present in the external phase) or micro-nanoparticles (if the monomer(s) is present in the internal phase). Furthermore, since the polymerization happens at the interface oil/water, a well-ordered/globular internal structure of the material is expected.

The monomers mixture should be provided with a backbone monomer, a crosslinker and a functional monomer. While the styrene/divinylbenzene system or is often proposed, here, monomers from the great family of acrylates and methacrylates are chosen for their more favorable biologic properties.

The family of acrylates/methacrylates could meet, by choosing the correct mixture of monomers, all the requirements of our materials. A biocompatible surfactant related to PEO-PPG co-copolymers or sorbitan based structures should also be selected to assure stability to the emulsions.

The characterization of the obtained materials at the solid state was performed by employing established techniques such as SEM, DSC, TGA, FTIR, mass loss, water uptake and solvent uptake, release of unreacted substances and density. FTIR was also used for semi-quantitative determination of hydrolysis of the epoxy groups from the functional monomer. Further characterization studies will be aimed to assess the effectiveness of the material to covalently link a model enzyme with specific biologic activities. Thus, the activity of the derived enzymatic support will be evaluated toward specific substrates.

Importantly, due to the semi-solid characteristics of the emulsions before polymerization and crosslinking, these systems are well suited to be shaped as needed; this versatility allows to forecast a multitude of applications in the pharmaceutical field, from biocatalysis to drug delivery.

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