

Magnetically controlled structure of silica monoliths for increased mechanical properties

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The use of nanoparticles to control the structure of materials is not a new idea, but most of the time their self-assembly leads to isotropic constructs. In this work, superparamagnetic nanoparticles have been used to magnetically control the structure of monolithic silica blocks. Due to their superparamagnetic behaviour, anisotropic structures can be synthesised. Monolithic silica gels with well-defined network structure have been synthesised via a sol-gel process, where superparamagnetic nanoparticles were added to the sol solution. The superparamagnetic nanoparticles, when submitted to an external magnetic field created by an electromagnet or a permanent magnet, align along the field direction. The aligned nanoparticles dictate the structure of the gel by acting as smart templates for structure control. Silica, having high affinity for the magnetite particles, will nucleate on the top of the magnetic particles completely covering them, and gelation will fix the structure permanently. A second magnetically controlled sol-gel step can be performed by impregnation of dry monolithic blocks with a sol solution, leading to a new dimension of controlled structure. Furthermore, a composite material containing a rubbery polymer will be formed out of the structure-controlled silica monoliths. We investigated the mechanical properties of the different monolithic blocks to gain a better understanding of the structure-properties relationship.

