Macroporous solid foams obtained in highly concentrated Pickering emulsions stabilized with magnetic nanoparticles

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Highly concentrated emulsions are characterized by an internal phase volume fraction that exceeds 0.74, which corresponds to the critical value for the most compact packing of monodisperse spherical droplets [1,2]. These emulsions can be used as templates for the preparation of macroporous materials, by polymerizing in the external phase and removing the internal phase that templates the formation of macropores [3-6]. Recently, it has been described that emulsions stabilized solely with nanoparticles (NPs) can be prepared with high contents of internal phase [7-8]. Emulsions stabilized by NPs, generally known as Pickering emulsions [9,10], can be very stable since particles can adsorb strongly at oil-water interfaces, and consequently NPs may act as an efficient barrier against emulsion instability [11]. In the present work, the main objective was to obtain low-density macroporous materials with superparamagnetic NPs attached to the pore walls. The presence of NPs on the pores may provide new functionalities to the macroporous solid foams. For this purpose, highly concentrated Pickering emulsions, stabilized solely with iron oxide NPs, were used as templates for polymerization of styrene. The results revealed that partially hydrophobic NPs could stabilize W/O highly concentrated emulsions with internal phase above 90%. Highly porous solid foams were obtained by polymerization in the external phase of such emulsions. This straightforward procedure allowed to obtain macroporous polystyrene magnetic foams with high porosities values (>80%) and low bulk densities. Density, porosity, pore morphology, specific surface area and magnetic properties were characterized as a function of NP hydrophilicity, concentration of NPs and internal phase volume. SEM imaging indicated that a close-cell structure was obtained. The nanoparticles retained their superparamagnetic behaviour, and consequently the macroporous foams may be used as magnetic absorbents.