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Preparation of functional environmentally responsive supports

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Abstract – The field of chromatographic separations would welcome any improvement in the existing commercial stationary phases. To this end, a promising possibility is the introduction of novel supports (i.e. either particles as packing materials or monoliths), whose retention behaviour may be controlled by varying environmental conditions (e.g. temperature and/ or salinity). Such supports are being prepared via functionalization with environmentally responsive polymers, namely PNIPAAM; Subsequently, their features and application performance are characterized and evaluated accordingly.

Stimuli-sensitive nanomodified polymer surfaces, exhibiting reversible changes in dimensions and hydro-philicity/ phobicity with simple environmental variations (i.e. temperature and salinity) can be particularly useful in purification processes, like chromatography.

In this work, seed latex nanoparticles were surface-functionalized with brushes of poly(*N*-isopropylacrylamide), PNIPAAM, a thermally responsive polymer with LCST of 32^{o}C, around which it undergoes a conformational transition. The chains were grown on the latex particles via ATRP, uniformly surrounding them above LCST (Fig. 1), while collapsing below LCST.

Under batch mode, the functionalized particles exhibit a high protein adsorption capacity at elevated temperature, becoming limited at lower temperature, whilst non-existent in the presence of large amounts of salt. This capacity is notably larger than the ones of both non-functionalized and industrially synthesized functional particles, being in fact comparable with that of commercially available chromatographic supports. Similar tests are also to be performed under continuous mode (packed columns).

Besides such systematic studies of particles' behavior (evaluation and comparisons), a transfer of this promising functionalization technology to monoliths is currently under way, due to their advantages as stationary phases, reasonably overcoming size exclusion and mass transport limitations that disfavor particles as packing materials for large biomolecules purifications. Mechanically rigid monoliths, with controlled pore size can be produced by "reactive gelation" [1] (Fig. 2). Our objective is to achieve a functional behavior in the confined interior of monoliths similar to this already accomplished for particles surfaces.

The assets of such materials for purifying biomolecules are considerable. Chromatographic separations can be easily controlled, by solely changing the eluent or stationary phase temperature, in reversible, swift and highly repeatable fashion. Harsh conventional adsorption/desorption conditions, affecting the quality of biological components, can be avoided. These would constitute a significant breakthrough for large-scale purification processes in terms of time, simplicity and overall efficiency.

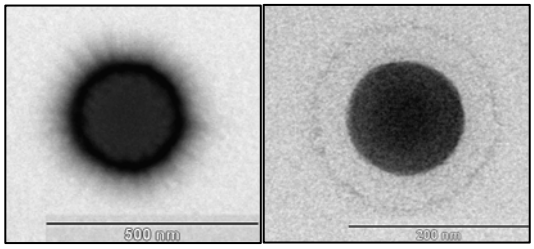

Figure 1: TEM images of nanoparticles functionalized with PNIPAAM chains below LCST.

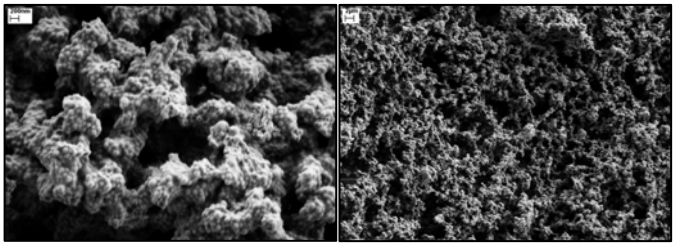

Figure 2: SEM images of monoliths produced by "reactive gelation".

[1] N. Marti, F. Quattrini, A. Butté and M. Morbidelli, Macromol. Mater. Eng. 290 (2007) 221-229.