# Bovine Serum Albumin (BSA) Interactions with Mesoporous Silica Nanoparticles at Isoelectric Point

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The analysis of the interactions between drug carriers, such as mesoporous silica nanoparticles (MSN) and serum proteins, such albumins, is important to optimize drug delivery systems features (e.g. extension of their lifetime). Once introduced in the bloodstream, nanoparticles encounter a variety of proteins, which are distinguished by their affinity for the nanoparticles' surface. When the protein corona is constituted by "opsonin" proteins (i.e. fibrinogen), the overall effect is a shortening of their lifetime. The opposite effect is obtained when the layer is formed by "dysopsonins" proteins (i.e. albumin) [1]. Protein adsorption is commonly performed at physiological pH (7.4), where both the protein and the MSN are negatively charged [2]. According to the DLVO theory, the interactions between protein and nanoparticles surface is governed by the interplay of the electrostatic ($E_{EDL}$) and van der Waals forces ($E_{vdW}$): $E_{DLVO} = E_{vdW} + E_{EDL}$

In this work, we investigate the adsorption of bovine serum albumin (BSA), used as a model protein dysopsonin, on bare (MSN) and amino-functionalized (MSN-$NH_2$) mesoporous silica nanoparticles at the protein isoelectric point (pH = 4.8). In these conditions $E_{EDL}$ contribution is minimized to highlight van der Waals, non-electrostatic forces. The two materials have been characterized through: dynamic light scattering and electrophoretic light scattering (DLS and ELS), FTIR spectroscopy, thermogravimetric analysis (TGA), $N_2$ physisorption, small angle X-Ray scattering (SAXS) and Transmission electron microscopy (TEM).

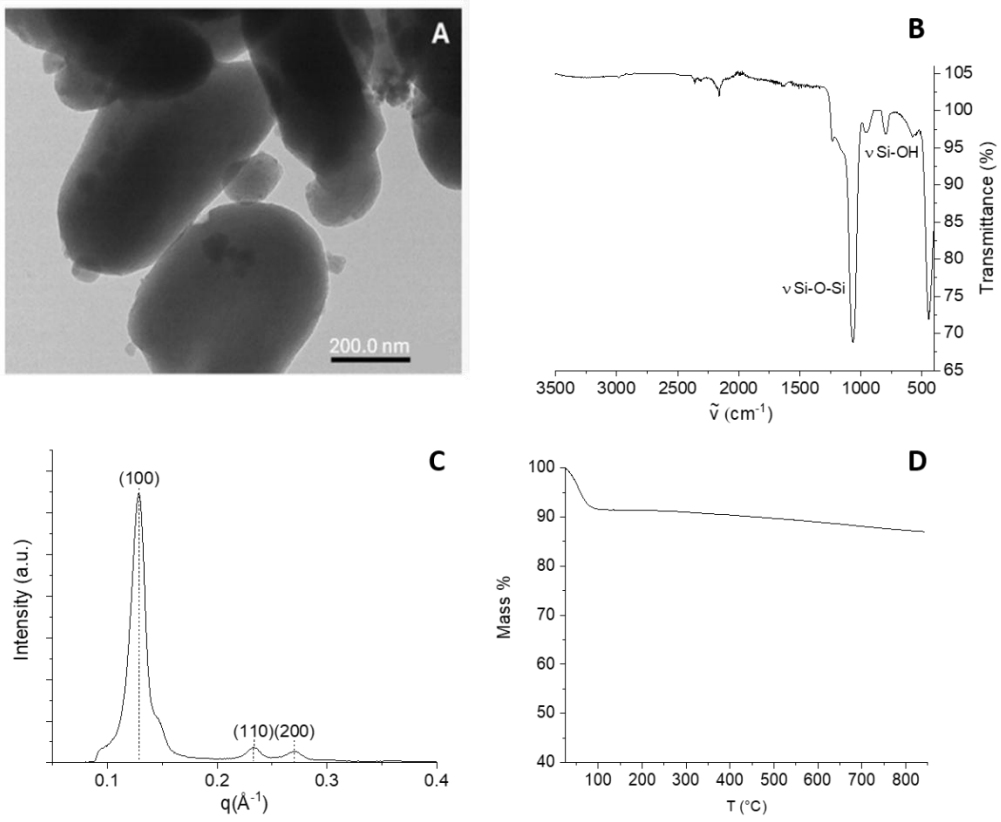


**Figure 1 -** MSN characterization: TEM image (A); FTIR spectrum (B); SAXS pattern (C) and TGA (D)

To evaluate BSA adsorption isotherms Uv-Vis spectroscopy and quartz crystal microbalance with dissipation monitoring (QCM-D) have been performed. UV-Vis results showed a higher Langmuir constant ($K_L$) for MSN but the highest maximum coverage ($q_{max}$) for MSN-$NH_2$ (117±15 vs 71±4 mg $g^{-1}$). On the other hand, regarding QCM-D measurements, the highest $q_{max}$ was found for MSN when compared with MSN-$NH_2$ (681±29 vs 603±14 ng $cm^{-2}$) together with a lower $K_L$ value for the bare material. To account for these findings, a computational model was proposed that extends DLVO theory by including an additional term based on the dipole moment of BSA. In addition to dispersion forces, protein dipolar interactions are not negligible and play an important role in governing the protein-nanoparticle interaction at the isoelectric point.

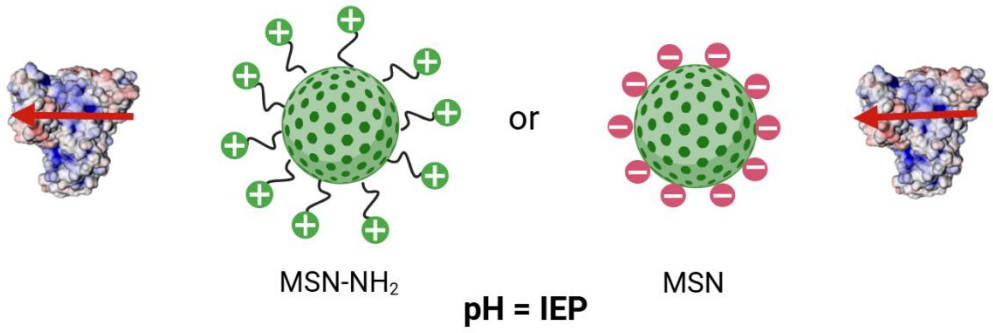


**Figure 2 -** BSA adsorption on MSN and MSN-$NH_2$: relation of the nanoparticles with the intrinsic dipolar moment of the protein

## REFERENCES

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