Investigating Protein Interactions with Clay Nanoparticles: Molecular and Supramolecular Insights

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Clay nanoparticles have emerged as promising platforms for biomedical applications due to their unique physicochemical properties, high surface area, diverse ion-exchange capacity, tunable surface chemistry, and excellent biocompatibility. [1] Understanding their interactions with proteins is essential for both fundamental biophysical insights and the design of biofunctional nanostructures. Protein adsorption onto clay surfaces involves diverse mechanisms, including surface adsorption, partial intercalation, and conformational adaptation, yet the molecular details of these processes remain incompletely understood. [2]

In this study, we investigate the interactions between two structurally distinct proteins—myoglobin and carbonic anhydrase which differ in their secondary structure—and synthetic clay nanoparticles, including imogolite nanotubes of two aspect ratios, [3] as well as beidellite and laponite. We aim to elucidate how nanoparticle structure and surface properties influence protein adsorption, conformational stability, and supramolecular organization.

We combine spectroscopic and scattering techniques to investigate protein–clay nanoparticle interactions at both molecular and supramolecular levels. At the molecular level, UV-Vis, fluorescence, and circular dichroism spectroscopy are used to quantify protein binding and monitor conformational changes, while small-angle X-ray and neutron scattering probe the structural organization of protein-nanoparticle assemblies at the nanoscale.

Preliminary results, suggest that protein adsorption and conformational changes are strongly influenced by the nanoparticle aspect ratio and surface properties, highlighting the importance of nanoscale design in biomedical applications.

Keywords:
clay nanoparticles; proteins; self-assembly;

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