Polysaccharide/Silica Hybrid Hydrogel Spheres for Controlled Drug Release

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Max Planck Partner Group on Colloidal Methods for Multifunctional Materials

Motivation

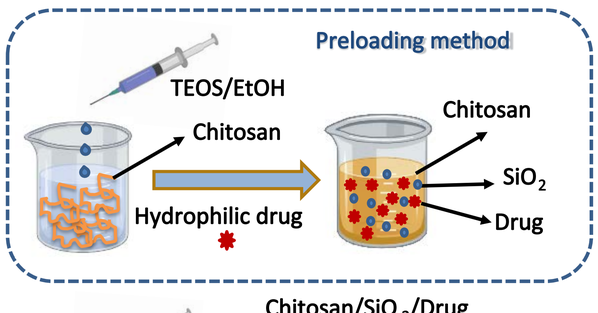
- Controlling the **release of pharmaceutical compounds** to specific action sites, with increased therapeutic benefit and minimized side effects or toxicity, is a major challenge in designing **biomedical carriers**.
- In recent years, **biodegradable polymeric materials** have attracted more attention as drug carriers. **Encapsulation of drugs in polymers** plays an important role in increasing the stability of drugs by protecting them from degradation, but it is also useful to control the release of the drug.
- Drugs can be encapsulated, entrapped or attached to the polymer matrix.

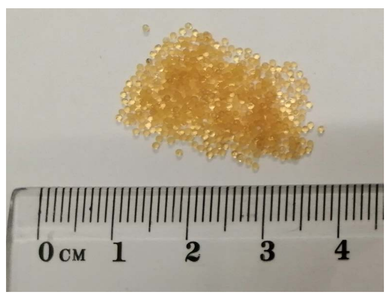
Overview of the Work

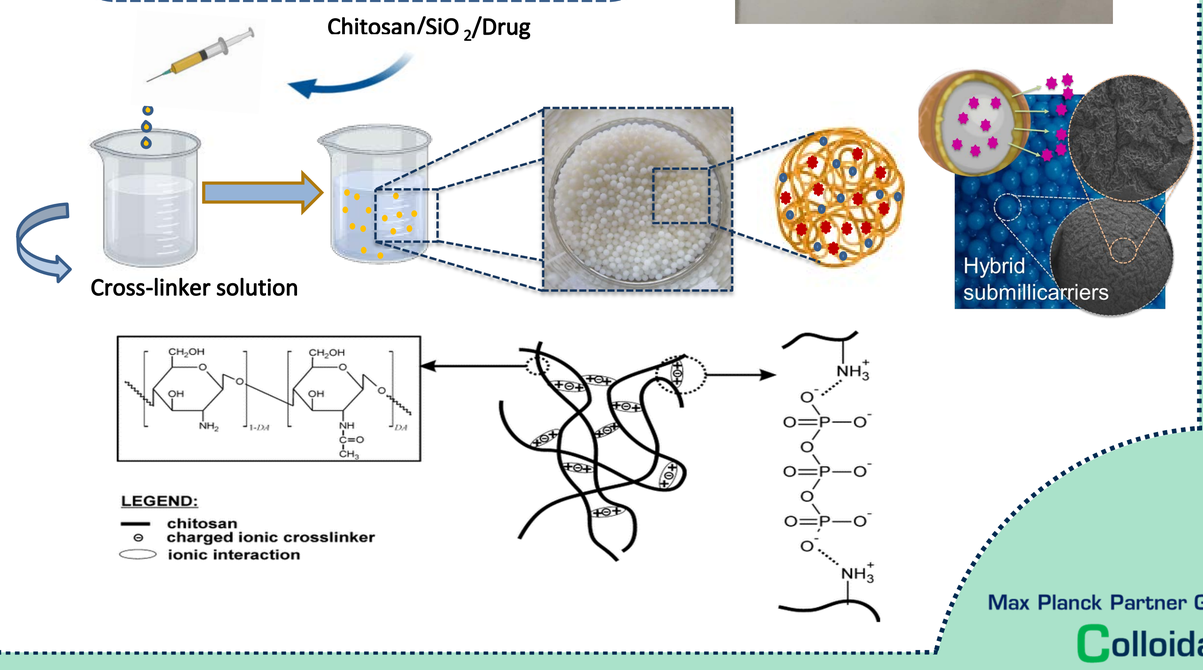
- In this work, we aim to prepare **an organic–inorganic hydrogel spheres** by ionotropic gelation, studying thereby their efficiency for entrapping **hydrophilic substances.**
- Chitosan and alginate are an **attractive biomaterials** due to their characteristic chemical and biological properties; they are biocompatible, biodegradable, and nontoxic.
- Incorporating **nanostructured silica** into the polymer matrix helps to overcome the limitations of the ionotropic method for entrapping hydrophilic substances.

Synthesis of Polysaccharide/Hybrid Silica Spheres

- The **ionotropic gelation method** involves the electrostatic interaction of a polyelectrolyte with an oppositely charged cross-linking agent.

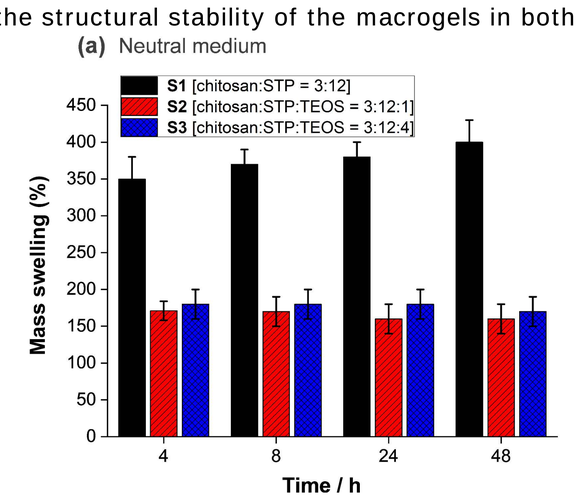


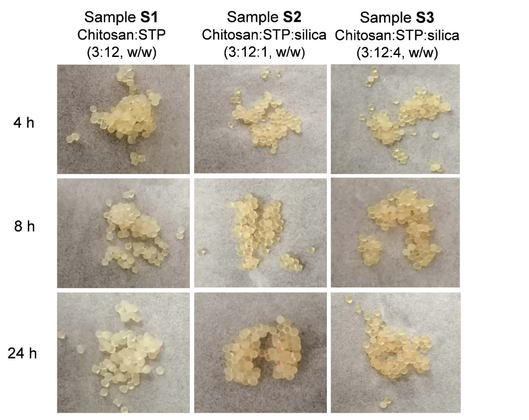


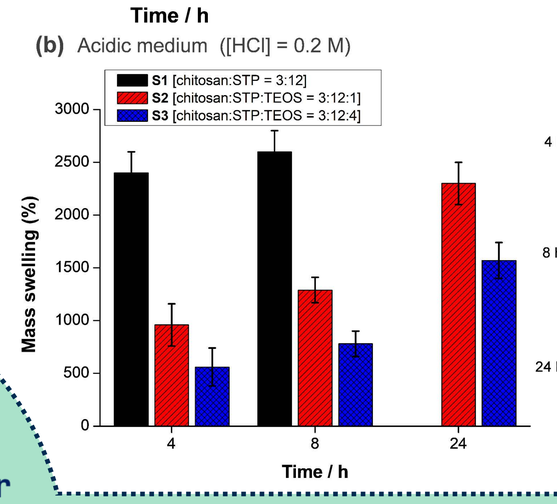


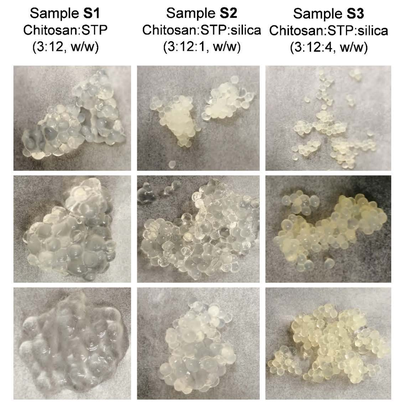
Swelling and Stability Studies in Different Media

- The **swelling ratio** was studied in both neutral and acidic conditions. The results indicate that the formation of nanostructured silica within the chitosan matrix increases the structural stability of the macrogels in both neutral and acidic media









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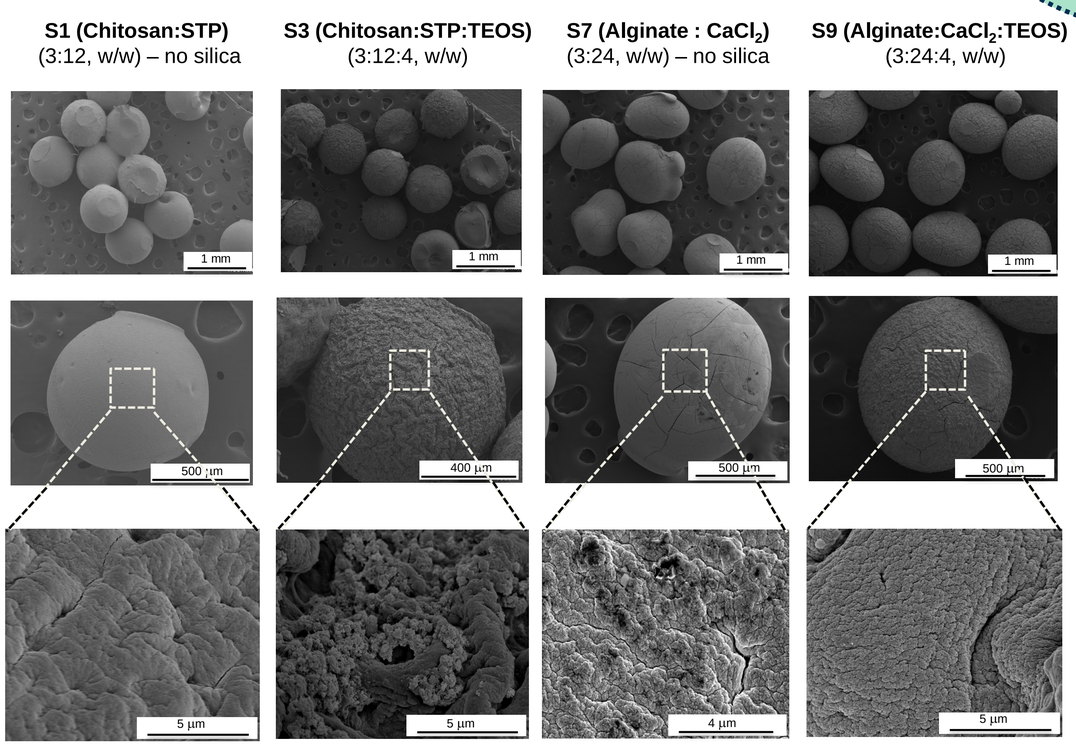
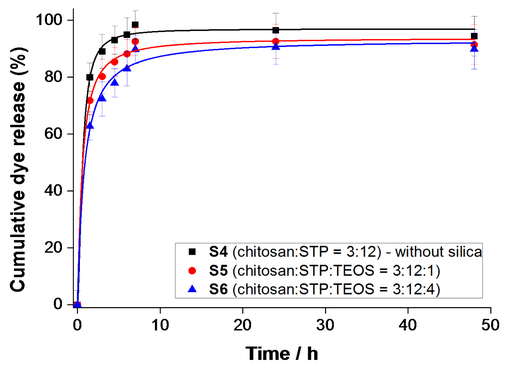
Surface Morphology of the Spheres

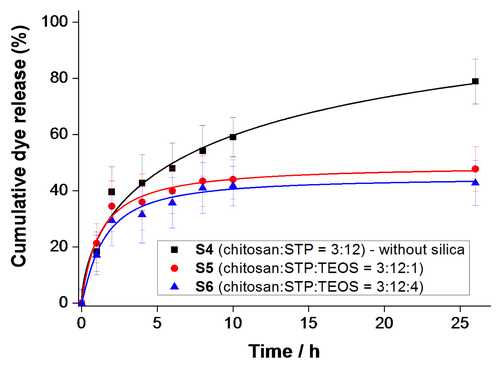
- **The surface morphology** of the polysaccharide hydrogel spheres was studied with scanning electron microscopy (SEM). Samples without silica present a regular and spherical structure with a smooth surface, samples with silica show a certain roughness, attributed to the presence of silica nanostructures embedded within the polymer matrix.

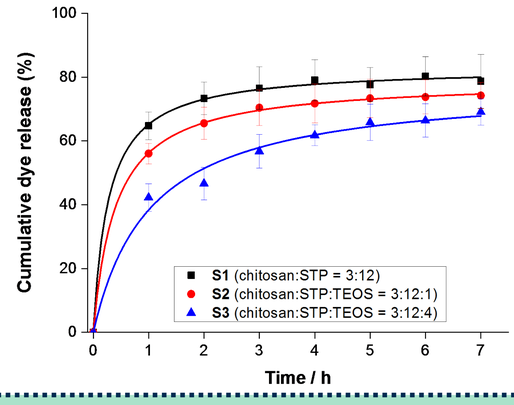


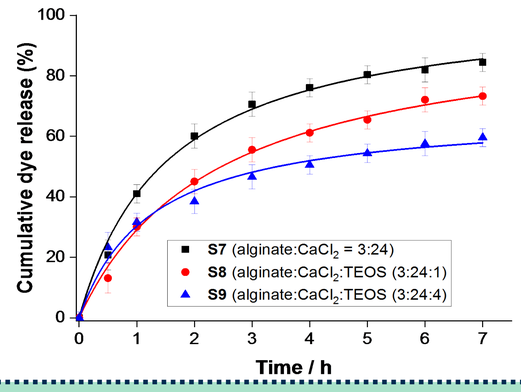
Release of Hydrophilic Substances

- Model **hydrophilic molecules** (erioglaucine disodium salt is shown in the graphs below) are encapsulated by an in-situ process. Kinetic studies demonstrate that the **release** of the active substance is slower in the presence of silica, which increases as well the structural stability of the carrier in both neutral and acidic media









Conclusions

- Chitosan and alginate were used as a polymer matrix for **encapsulating different hydrophilic substances**.
- Silica nanostructures were embedded in situ within the polymer matrix during the physical cross-linking **by ionotropic gelation process.**
- Silica nanostructures play a significant role in both **increasing the structural stability** of the spheres and **retarding the release** in both neutral and acidic environments.

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