Hydrogen bond driven association of cationic polysaccharides and non-ionic sugar-based surfactants

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Understanding non-electrostatic coacervation is critical for advancing sustainable formulations [1]. Here, hydrogen bond–mediated association between cationic polysaccharides (CP) and alkyl polyglucoside (APG), a bio-based nonionic surfactant, is investigated under varying ionic strength conditions. In contrast to conventional polyelectrolyte–surfactant systems governed primarily by electrostatic interactions, the CP–APG association arises exclusively from nonionic, hydrogen bond–driven mechanisms.

A combination of UV–visible spectroscopy, phase diagram analysis, and quartz crystal microbalance with dissipation monitoring (QCM-D) was employed to characterize both bulk phase behavior and the adsorption of CP–APG complexes onto negatively charged surfaces. The results demonstrate that APG concentration controls the onset of coacervation: intermediate surfactant concentrations induce phase separation, whereas increasing ionic strength promotes coacervate formation by enhancing hydrogen bonding interactions.

This process results in the formation of micron-scale coacervate droplets with a core–shell morphology, consisting of a hydrophobic APG-rich core surrounded by a hydrated CP shell, as supported by zeta potential measurements. Coacervation significantly enhances the deposition of CP–APG complexes on solid substrates, highlighting their potential for controlled release, targeted delivery, and surface functionalization applications.

Overall, these findings advance the understanding of non-electrostatic, hydrogen bond–driven coacervation in polymer–surfactant systems and demonstrate that ionic strength serves as a key tunable parameter for modulating structure, deposition, and performance. This work provides valuable insights for the design of sustainable formulations in cosmetics, biomedical coatings, food technology, and enhanced oil recovery. Future studies should further explore the effects of salinity, salt type, surfactant concentration, and dilution under conditions representative of real-world applications.

Keywords:
Alkyl polyglucosides, Hydrogen-bond-driven coacervation, Ionic-strength modulation, Quaternized hydroxyethylcellulose;

References:

[1] Puente-Santamaría, A.; Molina-Basurto, J. N.; Gerardin, E.; Ortega, F.; Rubio, R. G.; Guzmán, E. *J. Mol. Liq.* **2025** , *425* , 127259.

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