Controlling Complex Coacervates Through CO_2-Induced pH Shifts

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Complex coacervation is a form of liquid-liquid phase separation that can be formed via oppositely charge polyelectrolytes (PEs). They have gained interest for their ability to compartmentalize molecules, which may be controlled via stimuli. The ability of coacervates to reversibly respond to stimuli allows for the engineering of materials that are responsive and controllable. Changes in pH act as a stimulus by protonating or deprotonating weak PEs, thus strengthening or weakening the electrostatic interactions that drive coacervation. We propose a system using cycles of CO_2 and inert gas sparging to reversibly alter pH. This work focuses on the forward reaction of the coacervate system with CO_2. Complex coacervates of the polycation, poly(L-lysine hydrochloride), (Plys), and polyanion poly(D,L-glutamic acid sodium salt), (PGlu), are created. Next, the system is adjusted to an alkaline pH, allowing NaOH to deprotonate the ammonium group on PLys. This newly formed amine reversibly reacts with CO_2 to form bicarbonate and lower the pH. Additionally, NaOH reversibly reacts with CO_2, lowering the pH and producing bicarbonate and carbonic acid. We explore how the reduction in pH from the reaction changes size and charge of coacervates.

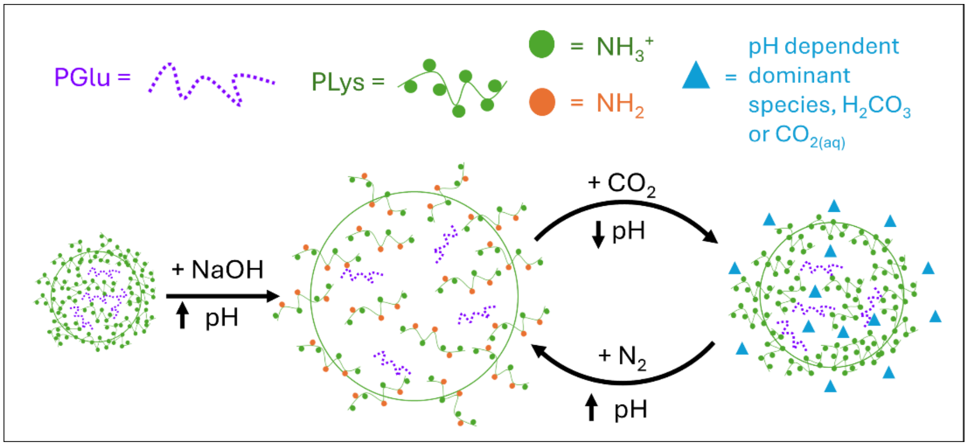

Figure 1: Reaction of coacervates with sodium hydroxide and subsequent sparging of CO_2