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Measuring Adaptation of pH-Sensitive Poly[2 (Dimethylamino)ethyl Methacrylate] Films

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Adaptation may play a role in materials science, biology, and engineering1, 2. Dynamic adaptation is more relevant than static wettability due to allowing for greater versatility, functionality, and control over surface properties3. The dynamic adaptation process of liquids on solid surfaces is a complex subject due to its involvement with different lengths and time scales4, 5. The challenge becomes even bigger for adaptive or responsive surfaces6, 7. This is because responsive surfaces are often very sensitive to environmental changes. Ensuring consistent performance under different conditions is very difficult.
However, there is currently limited research exploring the dynamic adaptation and kinetics of moving droplets on pH-responsive surfaces8. When a surface displays hydrophilic characteristics coupled with significant contact angle hysteresis, the resistive force overcomes gravitational force. Therefore, gravitational forces alone prove inadequate in initiating droplet movement. Static measurements are susceptible to sensitivity issues, as placing a drop on the surface results in a contact angle between the advancing and receding values. Consequently, effective surface adaptation must be both robust and rapid to minimize the contact angle. As a result, the currently available methods for assessing surface adaptation remain limited.
Our method employing a Titled-plate setup involved a pump to deposit droplets of varying pH onto inclined polymer surfaces and a high-speed camera to record. It allows us to facilitate and analyze contact line movement. We selected a pH-responsive polymer made from (2-(Dimethylamino) ethyl methacrylate (PDMAEMA) as a representative surface. PDMAEMA is pH sensitive with a surface charge zero point occurring at a pH of 7.6. We employed the Atom Transfer Radical Polymerization (ATRP) method to prepare polymer brushes on both flat silicon substrates and rough glass substrates. In this study, we pioneered the investigation of dynamic adaptability in liquid droplets with varying pH levels on both horizontal and inclined polymer surfaces using two distinct methods.

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