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# MAGNET-ASSISTED CONTROL AND RELEASE OF LIQUID-WRAPPED MAGNETO-RESPONSIVE HYDROGELS

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ABSTRACT

This study exploits the liquid-liquid encapsulation technique for encapsulating magnetic and non-magnetic hydrogels within a liquid medium, paving the way for diverse applications in biomedical technologies, soft robotics, and multifunctional materials. The method involves suspending magnetic and non-magnetic hydrogels in laser oil, followed by generating compound droplets, which are subsequently enveloped by an interfacial layer of canola oil floating on a water host bath. This process results in magneto-responsive, liquid-wrapped hydrogels capable of dynamic responses to external magnetic fields. The key advancements include magnet-assisted manipulation and controlled release mechanisms of magneto-responsive hydrogels inside the host water bath, demonstrating enhanced stability, tunability, and adaptability of these encapsulated cargos. Further, this work focuses on characterizing the magnetic Bond number, a critical parameter governing the release and manipulation of magnetic hydrogels under varying magnetic field conditions. The characterizations and corresponding regime maps offer valuable insights into the interplay between magnetic and interfacial tension forces, enabling precise control over encapsulated cargos.

Furthermore, the magnetic maneuverability of magneto-responsive cargos is harnessed to achieve underwater magnet-assisted coalescence. Our findings demonstrate that this technique allows for the selective release and arrest of magnetic hydrogels post-coalescence, depending on the applied magnetic field strength, which is modulated by adjusting the distance between the magnet and the encapsulated cargos. Notably, under specific magnetic field conditions, only the magnetic hydrogel can be released, while the non-magnetic hydrogel remains encapsulated, even when both are present within the same cargo post-coalescence. This study represents a significant advancement in non-contact, magnet-assisted actuation technologies, offering a versatile platform for developing dynamic and responsive systems. The seamless control of hydrogel release and manipulation highlights the potential for advancing controlled hydrogel technologies, enabling tailored functionalities for future industrial and scientific endeavours. This research broadens the scope of magneto-responsive materials and sets the foundation for the next generation of adaptive and multifunctional systems.