Biomimetic Removal of Microsphere Water Contaminants, via Calcite-Infused, Coral-Like Melamine Sponges

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The detrimental threat microplastics (MPs) have on the environment is well known. However, their effective and efficient remediation in aquatic environments has yet to be established. This research provides a highly efficient/practical method for the removal of microplastics through the creation of an Artificial Coral Sponge (ACS). The ACS was constructed on a 2x2x1.5cm (150μm-pore) melamine sponge, with a PTFE adhesion layer, and $CaCO_3$ for MP-capture. The ACS removed ~186k-MPs (~93%) in 45hrs, from 0.1mg/ml MP-contaminated seawater. High MP-concentration, long-term experiments were conducted to examine full capacity. Following one week of submersion in 0.5mg/ml MP-contaminated water, SEM analysis highlights MP-retention throughout its internal structure, demonstrating that it is not a surface-only remediation device. Furthermore, at full capacity, the ACS can retain up to 2065k MPs/device. To evaluate ACS reuse properties, an ACS was used 3x in subsequent 0.1mg/ml MP-contaminated seawater. Marginal decline of MP-remediation over 3 “reuses” highlights the ability to reapply the ACS in contaminated water until its MP-limit is reached. Prolonged stability studies demonstrate prolonged ACS integrity, as a marine-safe, easy-to-use MP-remediation tool costing 30¢/tested device, or $12 for a device that mimics a typical 625cm2 coral. Implementation is easy, as it is simply lowered into MP-contaminated water, left until its capacity is reached, and then lifted out for MP recovery. Based on measured “reuse” and maximum-load capabilities of the ACS, a 625cm2 surface area ACS could remediate up to 64.5 million microplastics in 116hrs, when placed in a continuous, 0.1mg/ml MP contaminated water resource.

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