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A Cell-free Polymer Material Platform: Dna-encoded Smart Materials For Sensing And Decontamination

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Synthetic biology has yielded advanced capabilities to design biological functions including sensing, biomolecule or material synthesis, and catalysis, all controlled by DNA-encoded instructions. A conventional approach to bioengineering requires delivering new DNA instructions to a living cell and relying on that organism to perform the desired function while also maintaining cell growth and viability. That approach poses challenges for the stability of the system outside of the laboratory and incurs regulatory limitations surrounding release of genetically modified organisms. An alternative to the cell-based approach is using cell-free systems. These non-living bio-reactions are capable of complex functions like sensing and molecule synthesis without being packaged in a cell. We have found that dried cell-free systems are remarkably stable to both high temperatures and exposure to organic solvents, enabling the delivery of sophisticated and dynamic bio-reactions to synthetic polymer materials. We demonstrate that cell-free polymer composites can perform protein synthesis, sensing, and production of a functional antimicrobial. The ability to cast bio-functionalized polymers with solvents and heat greatly expands the types of materials and form factors that could benefit from bio-activity. We envision future applications in multi-functional coatings, fibers, or objects embedded with sensing, decontamination, or material modifying functions.

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