Tunable SERS-Sensing Hydrogels for Direct Detection of Biotargets

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Food security is increasingly turning into a significant societal concern because of political upheaval and climate change. In this regard, annually, as much as 40% of worldwide crops are lost to pests, lowering agricultural production. Moreover, 420,000 fatalities annually are reported as a result of eating contaminated food. In the absence of efficient mitigation strategies, such as early detection, we will continue to be susceptible to food insecurity. Conventional approaches for identifying plant diseases and food contamination typically rely on low-accuracy techniques, including visual inspections and sensory evaluations. On the other hand, precise and high-specificity laboratory methods exist for these analyses, yet they cannot be conducted in situ. There is an urgent requirement for in situ examination for agricultural and food purposes

Our team has recently created a reagent-free SERS-sensing hydrogel designed for the direct detection of tobacco mosaic virus (genetic material) in infected plants. This technique relies on biosensors utilizing surface-enhanced Raman scattering (SERS) incorporated within a gel matrix. The biosensors are intended to activate independently upon encountering the target analyte, while the hydrogel acts as both a matrix for the biosensors and a means to collect the sample. Our preliminary efforts entailed utilizing naturally occurring hydrogels, which restricted our ability to examine how the characteristics of the hydrogel relate to improved sensing efficiency.

To this end, we are exploring the use of hyaluronic acid, a synthetic biopolymer that has been applied extensively for a variety of biomedical applications due to its diverse modification abilities. We aim to chemically alter the hydrogel polymer backbone, adjusting the polymer characteristics (e.g., charge) to align with the properties of the analyte. We propose to chemically refine this sensing platform to improve target uptake and function as an improved matrix for detection. Additionally, we aim at combining this sensing platform with aptamer-based sensors for *in situ* identification of small-molecule food contaminants.