Nanopore/Nanocavity-Based Structures as Surface-Enhanced Raman Spectroscopy (SERS) Platforms

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Abstract

By measuring the inelastic scattering of monochromatic light, Raman spectroscopy is a method used to examine vibrational, rotational, and other low-frequency modes in a system. However, compared to other spectroscopic methods like infrared spectroscopy, Raman signals are often weak, which limits their use in the bulk of applications where high sensitivity is needed. Surface-enhanced Raman spectroscopy (SERS) amplifies Raman signals for highly sensitive examination via nanostructured surfaces, such as metal nanoparticles. Nanopore and nanocavity-based structures, such as porous membranes and plasmonic nanoholes, show localized increases in electromagnetic fields, allowing for very sensitive optical detection. These structures are promising for a range of analytical and diagnostic applications in nanotechnology and biotechnology because of their excellent sensitivity and specificity. The present study aimed to conduct a review of the state-of-the-art SERS substrates based on nanopore/nanocavity structures. This study presents some interesting and significant results regarding the use of these structures in various fields. Moreover, future research directions are discussed in the final sections. The authors hope that this review provides researchers and academics insights into the application of nanopore/nanocavity SERS substrates and structures in different areas, such as biosensing, environmental monitoring, food safety, forensic applications, art, and archaeology.