Facile and inexpensive development of nano-structured polymer layers for Surface Enhanced Raman Spectroscopy applications

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Surface-enhanced Raman scattering (SERS) is a spectroscopic method for label-free detection of trace analytes, providing insights into the chemical bonds of molecules on nano-structured metal surfaces known as SERS substrates. Since its discovery with pyridine on silver, advancements in nanotechnology have led to various substrate fabrication methods, primarily using colloidal metal nanoparticles or electron beam lithography for nanostructured surfaces [1,2]. However, colloidal substrates can be unstable and prone to contamination, while electron beam lithography is costly and yields small active areas. This limits the mass production of large-area SERS substrates, hindering their widespread use [3]. Recent efforts have focused on low-cost, thin-film substrates, such as metal nanoparticle layers on flower petals or eggshell membranes [4, 5]. We report the development of low-cost nano-structured polymer surfaces for use as SERS substrates. This method involves molding a silicone elastomer (PDMS) over treated chicken eggshells. The eggshells are cleaned and etched in hydrochloric acid to create a nano-scale texture. A PDMS pre-polymer mixed with toluene is poured over the eggshell, which is then cured at room temperature for 24 hours. After dissolving the eggshell in hydrochloric acid, a PDMS layer with complementary nano-features remains. This layer is coated with a thin gold layer, which is expected to enhance Raman signals through localized surface plasmon resonance. Current efforts are focused on evaluating the nanostructured surface for SERS applications, with the thinning of the pre-polymer improving the interface by filling gaps in the eggshell mold.

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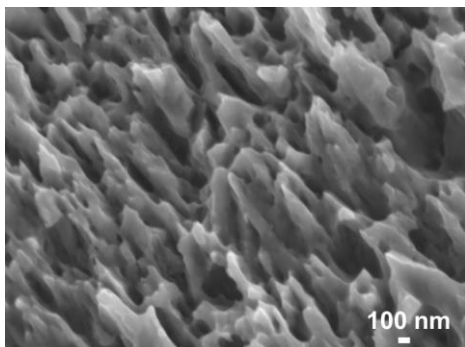
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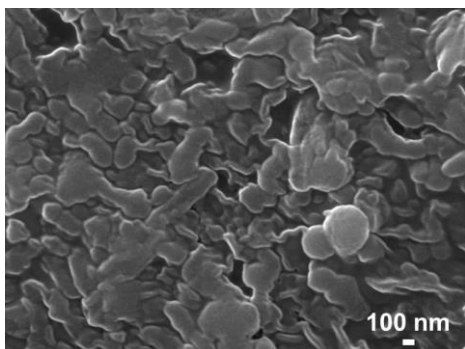Figure 1 Surface of chicken eggshell after controlled etching in hydrochloric acid.

Figure 2 Surface of PDMS after molding over a treated eggshell.