# Detection of biofilm microenvironment based on surface enhanced Raman spectroscopy technology

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**Abstract** The impact of marine microbial corrosion on the environment is increasingly significant, so it is of great significance to study the mechanism of microbiologically influenced corrosion. Biofilm is a biological structure composed of microbial communities, which directly affects the electrochemical reaction paths and processes at the corrosion interface, so it is crucial for the detection of the biofilm microenvironments. In this work, Surface-enhanced Raman scattering (SERS) technology was used to develop corresponding Raman probes for efficient, rapid and in-situ detection of metabolic products and corrosion products in the microenvironment of SRB biofilm, in order to achieve high sensitivity and high resolution detection of biofilm microenvironments in marine environments. Firstly, A Au@4-MBN@Ag@ZIF-8 nanoprobe with ZIF-8 as the capping shell was prepared, which used Au nanoparticles as the core and Ag as the enhanced signal layer to modify the 4-MBN signal molecules. The Au@4-MBN@Ag@ZIF-8 nanoprobe can utilize the ZIF-8 shell, Ag signal layer to react with sulfide, achieving a highly sensitive and specific response towards sulfide. In addition, a methylene blue (MB)-Au@Fe3O4 core-shell complex nanoprobe was constructed with a hybrid method using Au nanoparticles as a SERS-enhanced substrate, by integrating magnetic Fe3O4 nanoparticles, and modifying MB signaling molecules. Using the differences in the photodegradation ability of different iron-containing corrosion products to MB signaling molecules of the MB-Au@Fe3O4 nanoprobe, the differentiated detection of different iron-containing corrosion products was realized, and the semiconductor products generated by microbial corrosion in biofilms were successfully detected.

**Keywords** Surface-enhanced Raman spectroscopy; Biofilm; Microenvironment; Sulfate-reducing bacteria; Marine microbial corrosion.