Plasmonic Detection of Small Molecules for Real-time Monitoring of Biological Gas Conversion

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Indirect prediction of dissolved gas level from partial pressure using chromatographic analysis has been widely used to determine feed level and optimize production in biological gas conversion. In this method, the reactor is assumed to be in an equilibrium state. However, it suffers from a low reliability due to non-equilibrium factors of practical bioreactor such as bacterial metabolism or mechanical agitation. Furthermore, the bioreactor is often contaminated during off-line sampling. Here, we propose a direct plasmonic detection of dissolved small molecules based on surface-enhanced Raman spectroscopy (SERS) by integrating metallic nanostructures with bioreactor. First, colloidal nanoparticles are self-assembled at air/water interface and transferred onto transparent polymeric substrates. Then, this optical sensor is combined with bioreactor to collect optical signal of dissolved gas feed and metabolite molecules. To enhance the sensitivity, physical (e.g., electrostatic) or chemical adsorption onto metallic nanostructures is exploited. In addition, the stability of nanostructures under high shear stress and the response time under dynamic concentration change are also tested.