Rapid and accurate diagnosis for pathogens and their antibiotic susceptibility is critical for controlling bacterial infections. Conventional methods for determining bacterium’s sensitivity to antibiotic depend mostly on measuring the change of microbial proliferation in response to the drug. Such “biological assay” inevitably takes time, ranging from days for fast growing bacteria to weeks for slow-growers. Here, a novel tool has been developed to detect the “chemical features” of bacterial cell wall that enables rapid identification of drug resistant bacteria within hours. The surface-enhanced Raman scattering (SERS) technique based on our newly developed SERS-active substrate was applied to assess the fine structures of the bacterial cell wall. The SERS profiles recorded by such a platform are sensitive and stable, that could readily reflect different bacterial cell walls found in Gram-positive, Gram-negative, or mycobacteria groups. Moreover, characteristic changes in SERS profile were noticed in the drug-sensitive bacteria at the early period (i.e., 1 hr) of antibiotic exposure, which could be used to differentiate them from the drug-resistant ones. The SERS-based diagnosis could be applied to a single bacterium. The high-speed SERS detection represents a novel approach for microbial diagnostics. The single bacterium detection capability of SERS makes possible analyses directly on clinical specimen instead of pure cultured bacteria.

Left: artist’s view of a bacterium on nanoparticle-array illuminated by laser to generate SERS from its cell wall.

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