

Lysa MAHTOUT

Yun LUO, Delphine ONIDAS, Ernestine GAILLARD, Nordin FELIDJ, Claire MANGENEY

LCBPT, UMR 8601 CNRS, Université Paris Cité, 45 rue des Saints-Pères, 75006 Paris, France

lysa.mahtout@etu.u-paris.fr

Gold Nanoparticle–Agarose Hydrogels for Indirect SERS Detection of Thiolated Biomarkers

Early and selective biomarker detection remains challenging for analytes with weak Raman activity or limited affinity for SERS substrates. Surface-enhanced Raman spectroscopy (SERS) offers high sensitivity and specificity for such applications.¹ Here, we developed an indirect SERS platform based on functionalized gold nanoparticles embedded in an agarose hydrogel. Gold nanoparticles (45.9 ± 5.5 nm, plasmon at 533 nm) were synthesized by the Turkevich method and functionalized with aryldiazonium salts bearing nitrophenyl (Au@NO_2) or cyanophenyl (Au@CN) Raman reporter groups, exploiting the robust organic layers formed by this chemistry.^{2,3} The nanoparticles were embedded in agarose hydrogel, chosen for its porosity and compatibility with SERS-based sensing.⁴ Rather than detecting the analyte directly, our strategy monitors modulation of the reporter's SERS signal upon analyte binding. Immersion in cysteine and glutathione solutions (thiol-bearing analytes) produced a clear, reproducible modulation of the reporter bands at 1 mM, whereas creatinine and uric acid (non-thiol controls) gave no response.⁵ Au@NO_2 hydrogels showed the strongest signal. This work establishes a robust, selective hydrogel-based SERS platform for indirect detection of Raman-silent thiolated biomarkers, with promising applications in biomedical diagnostics and environmental sensing.

References

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Figures

Figure 1: Raman spectra of an Au@NO_2 -agarose hydrogel before (black) and after (red) 60 min immersion in 1 mM cysteine, showing modulation of the $\nu(\text{NO}_2)$ reporter band at 1341 cm^{-1} .

