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Social Impact of Gold Nanotag for On-dose-authentication of Tablets

Surface-enhanced Raman scattering (SERS) has attracted the interest of spectroscopists focused on ultra-high sensitivity and nanostructure fabrication. Recently, its unique properties have sparked new applications in anti-counterfeiting and pharmaceutical traceability. As counterfeit medicines become a serious global threat [1], rapid advances in nanotechnology have accelerated the development of SERS tags with the reporter molecule serves as a cryptographic code, enabling digitized authentication [2].

We have developed longevous self-assemblies of gold nanoparticles (AuNPs) that exhibit unique localized surface plasmon in the near-infrared region. For on-dose authentication, we mix a reporter molecule and AuNPs and directly applied the resulting SERS tags onto pharmaceutical tablets. Approximately 10 ng of the nanotag was dispensed onto the surface of a tablet and stored at room temperature. Using a portable Raman spectrometer equipped with a 785 nm laser, a distinct SERS spectrum derived from the reporter molecule was detected within 1 second of measurement. Notably, the SERS tags used in this experiment were synthesized in 2014 and stored on commercial tablets at room temperature. The SERS signal remained clearly detectable even after nine years (Figure 1) and continues to be observable today [3].

In an industrial coating process, placebo tablets were coated with a formulation containing SERS tags. There was no visible difference between tablets with and without nanotags. Furthermore, no significant degradation of SERS activity was observed after abrasion resistance testing or after heat treatment at 80°C for 6 hours. When stored in press-through packs (PTPs) designed to block light, the nanotags remained detectable. Once the NIR laser penetrated the PTP and reached the tablet surface, the SERS signal could still be reliably obtained [4,5]. These SERS nanotags are expected as new PUFs (physical unclonable functions) which can identify individual tablets on supply chain security.

References

[1] T. K. Mackey and G. Nayyar, Expert Opinion on Drug Safety, 2017, 16, 587.
[2] T. Fukuoka, et al., Sci. Rep., 2022, 12, 985.
[3] T. Fukuoka, et al., Adv. Mater. Interfaces, 2023, 10, 2370064.
[4] T. Yasunaga, et al., Int. J. Pharm., 2022, 624, 121980.
[5] T. Yasunaga, et al., Int. J. Pharm., 2024, 666, 124810.

Figures

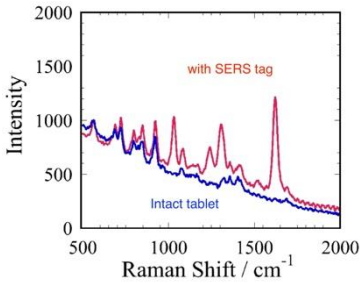

Figure 1: SERS spectra measured for 1 s through the PTP, 3,286 days after dispensed onto the tablet [3].