

ANUCHA Chukwuka Bethel ¹

SISKOVA Karolina ¹

¹ Palacký University, 17. listopadu 12, Olomouc 77900, Czech Republic

chukwukabethel.anucha@upol.cz

Ag Modified CeO₂ and CeO₂/Rh Colloid for SERS Detection of Caffeine and Atrazine in Water

Surface Enhanced Raman Spectroscopy (SERS) has undoubtedly matured into one of the most powerful analytical techniques engaged in diverse scientific domains ¹. The dominating prowess of the technology continues to register milestone advancements- thanks to nanoscience-enabled SERS breakthroughs ². As key SERS methods of nanostructure fabrication techniques, high spatial and temporal resolution, quantification of enhancement factors and qualitative analysis evolves, tremendous progress have equally been registered in material expansion and generalities of SERS substrates ³. To this end, there has been a paradigm shift from the foundational single element SERS substrates of Au, Ag, Cu to the exploration of other materials either alone or in combination with them for substrate pool enlargement targeting SERS signal enhancement, reproducibility improvement, and extension of detectable range of analytes. In contribution we evaluated respectively in solution the SERS test performance of Ag modified CeO₂ nano colloid, and Ag modified CeO₂/Rh-transition metal carboline nano colloid scaffold over caffeine and atrazine as model contaminants of emerging concern (CECs). In both cases, 0.0125 % CeO₂ anchored Ag colloid and 0.00625 % each of CeO₂ and Rh anchored Ag colloid, were added and digested mechanically as adjuvants into the Ag colloid. Optical and structural measurements of UV-Vis. spectroscopy for absorption wavelength, dynamic light scattering (DLS) for size distribution, and transmission electron microscopy (TEM) for average particle size determination were performed on obtained materials. CeO₂@Ag registered an absorption wavelength maximum of 422 nm same as the control Ag material, while CeO₂/Rh@Ag gave a 399 nm. DLS measured 96.42±1.56 nm, 125.1 ± 2.5 nm, and 123.27 ± 2.2 nm respectively for Ag, CeO₂@Ag, and CeO₂/Rh@Ag materials for particle size distribution. Average particle size by TEM were 63.89 ± 2.93 nm, 78.19 ± 2.55 nm, and 77.37 ± 2.65 nm. In a one-off preliminary test, SERS performance evaluation of the CeO₂/Rh@Ag material over caffeine registered a better outcome over the unmodified Ag, reaching an LOD of 3.125 mM in solution. On the other hand, the CeO₂@Ag modified material also performed better for a preliminary SERS test over atrazine with respect to the unmodified Ag material; reaching an LOD of 3.125 mM in solution. By this outcome, we have demonstrated enhanced SERS activity performance of Ag with catalytic adjuvant amount of metal oxide (CeO₂), and a combination of same in equal proportion amount with a transition metal carboline scaffold of Rh in equal % over the detection of caffeine and atrazine as model contaminants of emerging concern (CECs) in water.

References

- [1] Itoh, T.; Prochazka, M.; Dong, Z.-C.; Ji, W.; Yamamoto, Y.S.; Zhang, Y.; Ozaki, Y., Chem. Rev. 123 (2023) 1552-1634
- [2] Ding, S.-Y.; Yi, J.; Li, J.-F.; Ren, B.; Wu, D.-Y.; Panneerselvam, R.; Tian, Z.-Q., Nat. Rev.: Materials 1 (2016) 1-16
- [3] Ren, B.; Liu, G.-K.; Lian, X.-B.; Yang, Z.-L.; Tian, Z.-Q., Anal. Bioanal. Chem. 388 (2007) 29-45