Silver-coated nanostructured boehmite surfaces as substrates for Surface Enhanced Raman Spectroscopy

A. Dimitriou[1], S. Richardson[1], G. Geka[2], A. Kanioura[2], F. Kalogeropoulou[2], M Angelopoulou[2], D. Tsounidi[3], I. Raptis[3], S. Kakabakos[2], P. Petrou[2] and N. Papanikolaou[1]

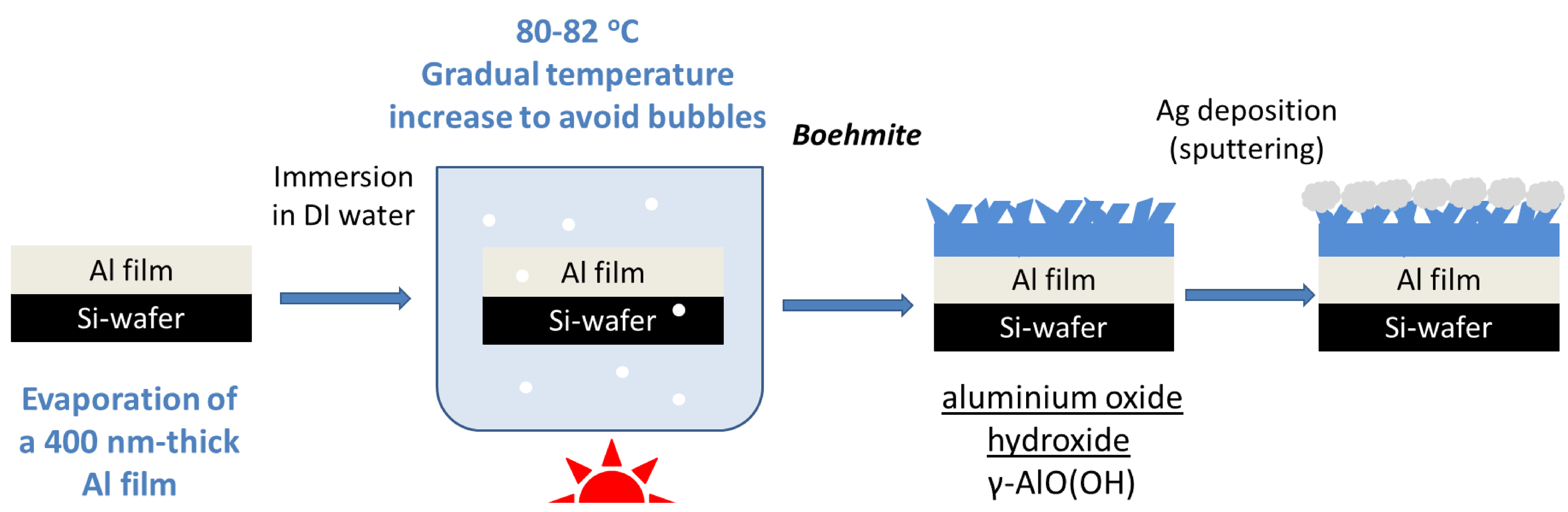
[1] Institute of Nanoscience & Nanotechnology, and [2] Immunoassays/Immunosensors Lab, Institute of Nuclear & Radiological Sciences & Technology, Energy & Safety, NCSR "Demokritos", Aghia Paraskevi, Greece

[3] ThetaMetrisis, S.A., 12132, Athens, Greece

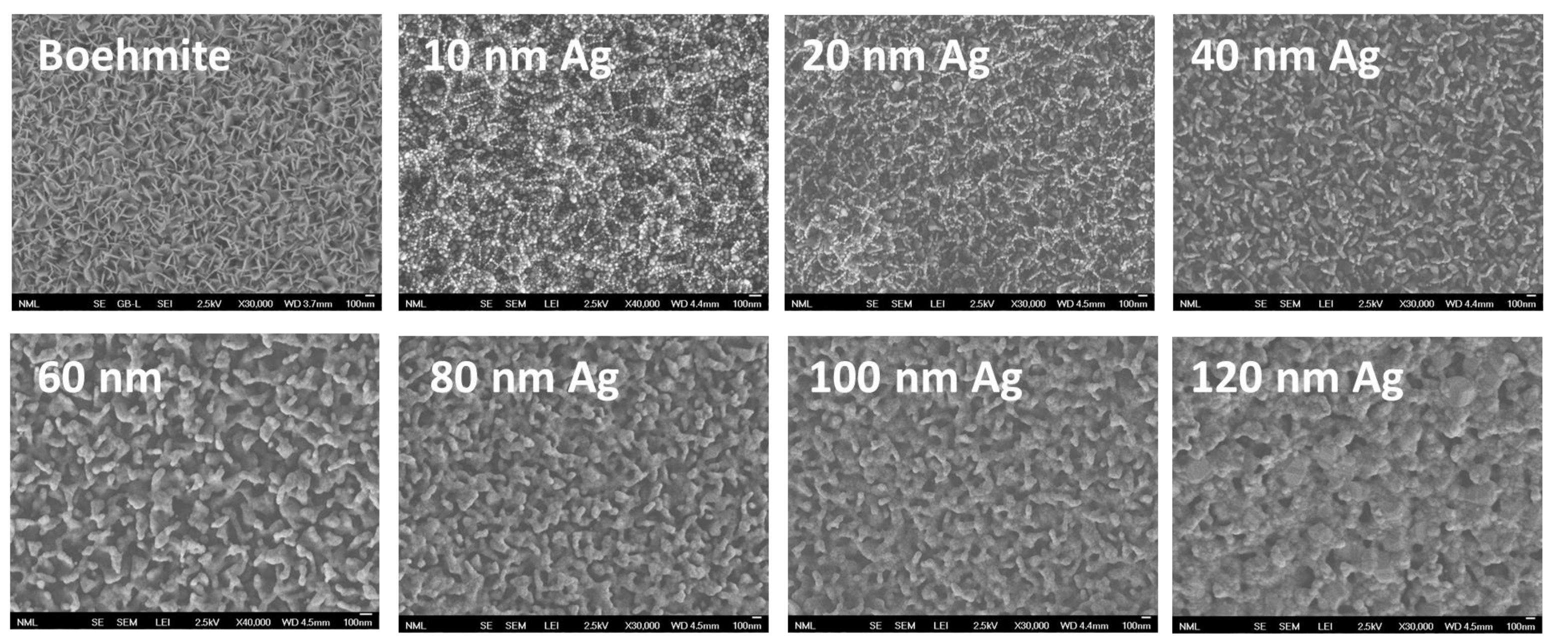
INTRODUCTION

Metallic nanostructured surfaces significantly enhance the intensity of Raman signal arising from molecules immobilized on them [1]. This detection approach that is known as Surface Enhanced Raman Spectroscopy (SERS) has expanded the application areas of Raman spectroscopy to biosensing due to minimal interferences from the sample matrix. To take full advantage of SERS for biosensing, substrates offering high enhancement factor along with uniformity over a large area and facile and reproducible fabrication are required. In the current work, silicon surfaces were first covered with an aluminum layer and then subjected to thermal treatment at aqueous environment to partially oxidize the aluminum layer creating a boehmite nanostructures on top of which silver is deposited by sputtering to create the SERS substrates [2].

Preparation of SERS substrates

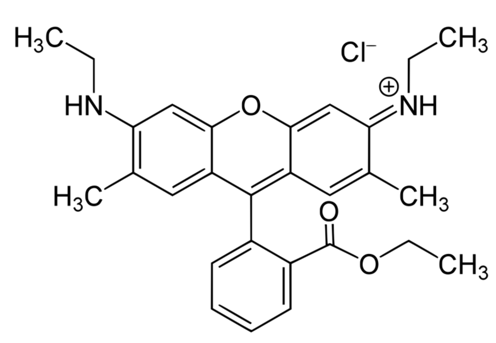


SEM characterization of SERS substrates

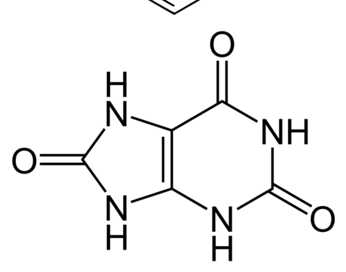


Evaluation of SERS substrates

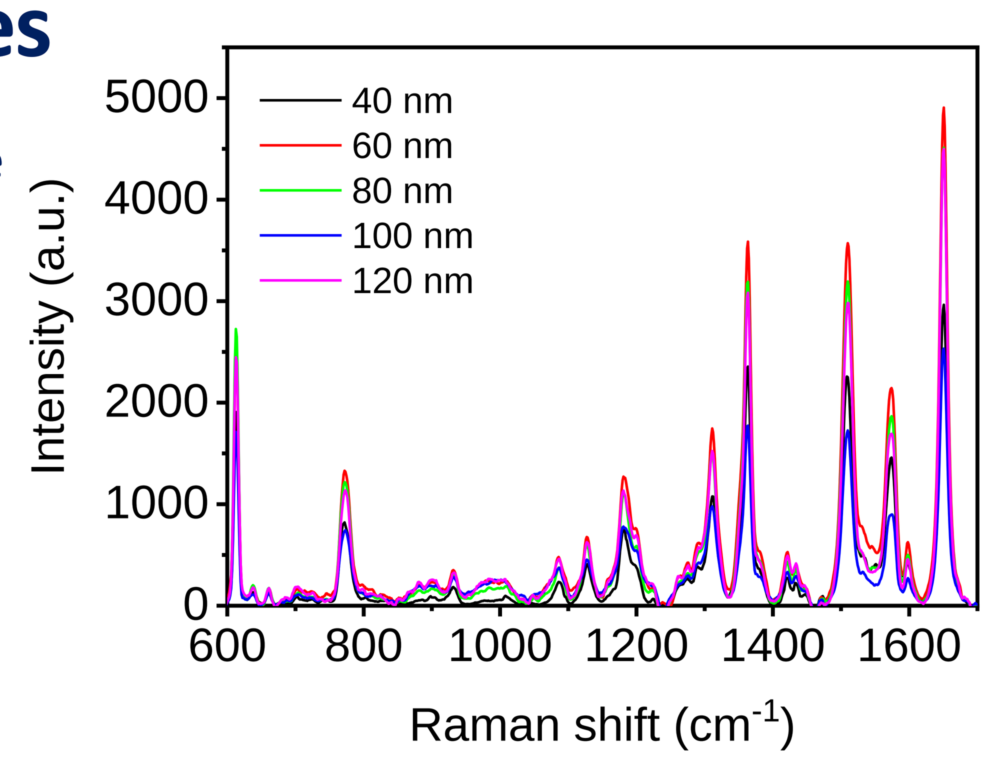
Rhodamine 6G



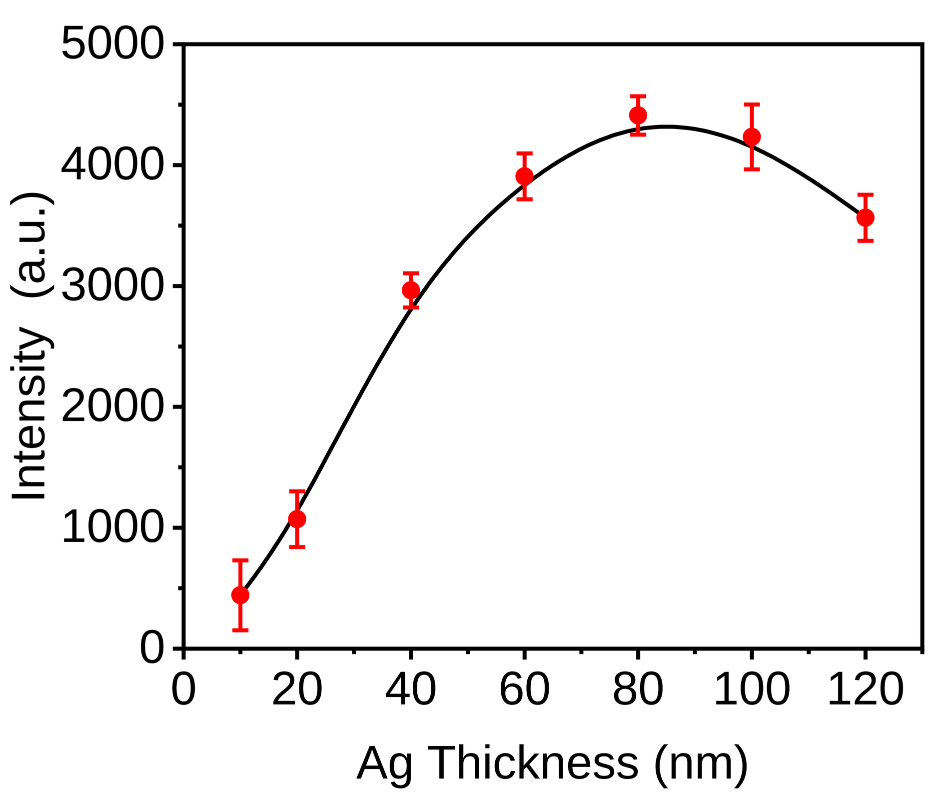
Uric acid

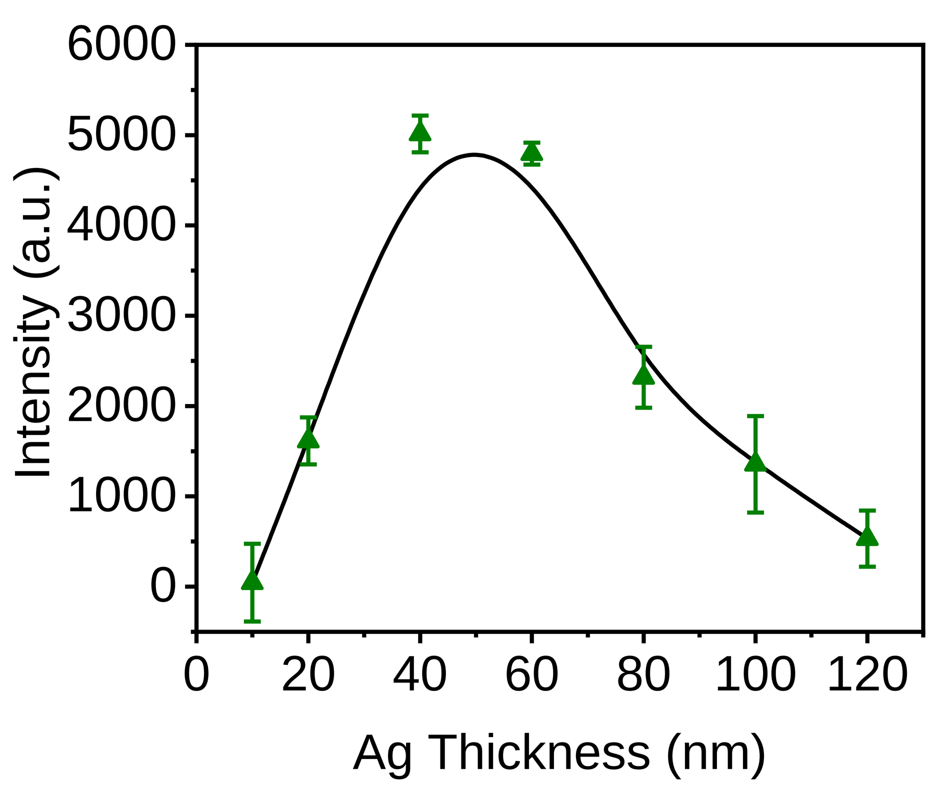


Renishaw inVia Confocal Raman microscope
×20 objective lens
Laser 785 nm, 10 mW
1 s acquisition time
30 measurements/sample
5-μL solution left to dry

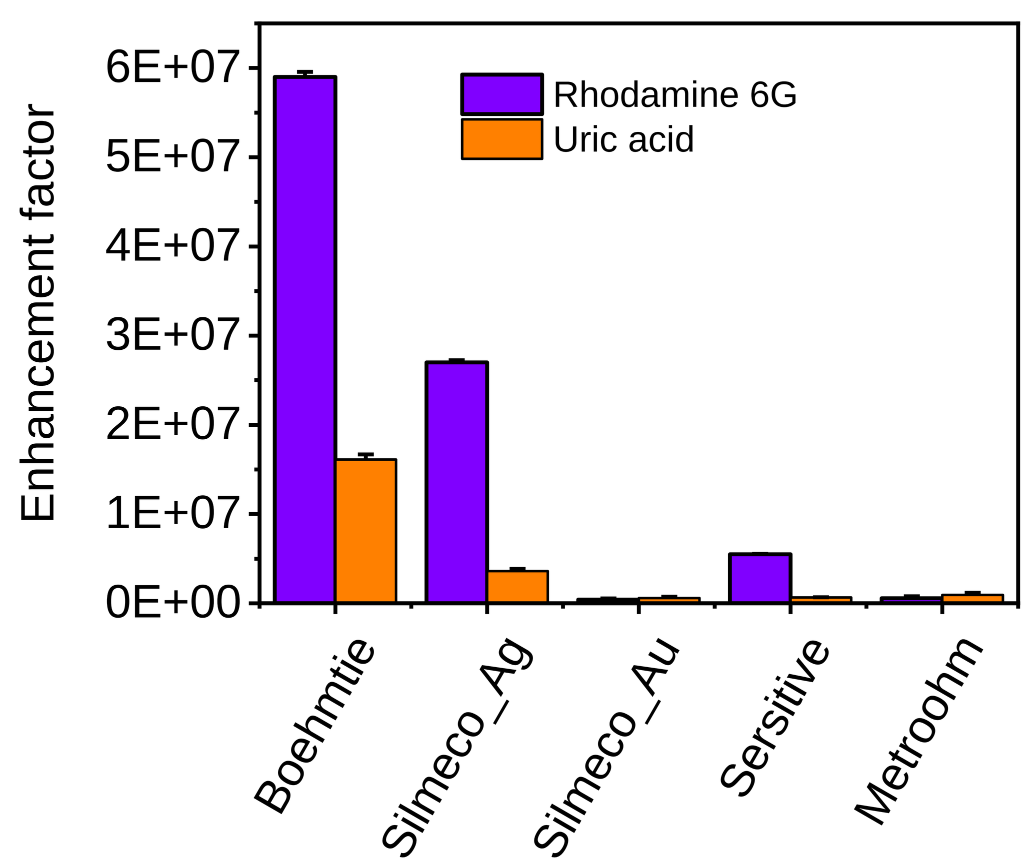


Raman spectra of 10^{-6} M Rhodamine 6G aqueous solution





Peak intensity at 1650 cm^{-1} for Rhodamine 6G (left) and at 1130 cm^{-1} for uric acid (right) vs. Ag layer thickness.



Raman signal enhancement vs. commercial substrates

CONCLUSIONS

- Using boehmite substrates covered with 80-nm thick silver layer **enhancement factors over 10^7** were achieved for Rhodamine 6G, whereas for uric acid substrates with a 40-nm Ag layer provided the higher enhancement factor.
- The achieved **enhancement factors were significantly higher** compared to those obtained by **commercial substrates**.

References

1. D. Cialla-May, A. Bonifacio, A. Markin, N. Markina, S. Fornasaro, A. Dwivedi, T. Dib, E. Farnesi, C. Liu, A. Ghosh, M. Schmitt, J. Popp, TrAC Trend Anal. Chem. 181 117990 (2024)
2. A. Dimitriou, A.S. Kastania, P. Sarkiris, V. Shvalya, N. Papanikolaou, U. Cvelbar, E. Gogolides, Micro Nano Eng. 24 100279 (2024)

Acknowlegement

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