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# Rapid Single Step Atmospheric Pressure Plasma Jet Deposition of a SERS Active Surface

Oliver S. J. Hagger[a], M. Emre Sener[b], Imran Khan[c], Francis Lockwood Estrin[a], Stefanos Agrotis[a], Albertus D. Handoko[d], Ivan P. Parkin[a] and Daren J. Caruana[a]*

[a] Department of Chemistry, Christopher Ingold laboratories, 20 Gordon St., London, WC1H 0AJ.

[b] Setaş Color Center, Tekirdağ / Turkey

[c] Defence Science and Technology Laboratory (Dstl), Porton Down, Salisbury, Wiltshire, SP4 0JQ UK

[d] Institute of Materials Research and Engineering (IMRE), Agency for Science, Technology and Research (A*STAR), 2 Fusionopolis Way, Innovis #08-03, Singapore 138634, Republic of Singapore, Singapore.

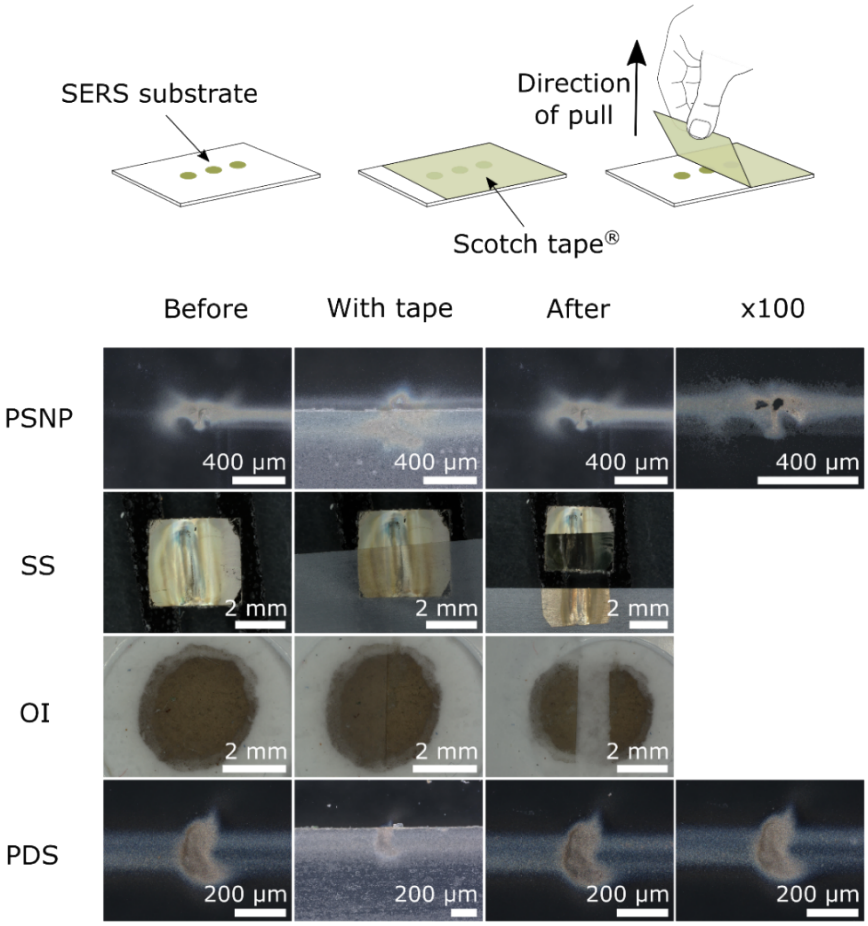

**Figure S1**. (a) depicting the scotch® tape adhesion test for the four silver SERS substrates. (b) optical images of the four substrates before application of tape, with the tape on, and after the tape was removed.

**Table S1.** All enhancement factors for each substrate were calculated using the following equation: $I_{SERS}$ / $I_{BULK}$ x $C_{BULK}$ / $C_{SERS}$. The 1586 $cm^{-1}$ peak was used for all enhancement factor calculations for the bulk sample and SERS substrates. A solution of 1M 4MBA was used as the blank; the peak intensity was measured to be 46 au.

| | **PSNP** | **SERSitive** | **OI** | **PDS** |
|---|---|---|---|---|
| Working | $\frac{53230}{46} x \frac{1}{1 x 10^{-4}}$ | $\frac{45542}{46} x \frac{1}{1 x 10^{-4}}$ | $\frac{30368}{46} x \frac{1}{1 x 10^{-4}}$ | $\frac{18541}{46} x \frac{1}{1 x 10^{-4}}$ |
| Enhancement factor | **$11.6 \times 10^{-6}$** | **$9.9 \times 10^{-6}$** | **$6.6 \times 10^{-6}$** | **$4.0 \times 10^{-6}$** |

**Table S2.** Comparing the cost of various commercial Ag and some Au SERS substrates against the PDS SERS substrate produced by work reported in this report.

| Manufacturer | Substrate material | Cost per substrate (£) [August 2022] |
|---|---|---|
| PDS substrate | Ag | 0.46 |
| Ocean Insight | Ag | 12 |
| Hamanatsu | Ag | 95 |
| SERSitive | Ag | 17 |
| Nikslyte | Au | 43.50 |
| StellarNet | Ag | 8.20 |

**Table S3.** Analysis of the cost calculation for plasma jet deposition.

| Component | Working | Cost |
|---|---|---|
| Plasma | Time for each spot (including movement time) = 6 seconds<br>256 spots x 6 s = 1536 s<br>1536 s x 14 W = 21504 Ws<br>21504 Ws = 5.97 x $10^{-3}$ kWh<br>Cost per kWh (UK, February 2023) = 34 p $kWh^{-1}$<br>Cost per substrate = 0.20 p | 0.20 p |
| Electricity | For 1536 second deposit<br>Nebuliser = ~300 W = 460800 Ws = 4.35 p<br>Syringe pump = 10 W = 215040 Ws = 0.15 p<br>Waveform generator = ~20 W = 600 Ws = 0.29 p<br>Physik Intrumente = 48 W = 1440 Ws = 0.70 p * 3<br>Computer = 100 W = 3000 Ws = 1.45 p | 8.53 p |
| $N_2$ | Cost per cylinder = £ 10.87<br>Pressure of cylinder = 200 bar<br>Size of cylinder = 2.61 $m^3$ = 2610 L<br>Flow rate = 1.5 L $min^{-1}$<br>1.5 L $min^{-1}$ x 25.6 min x (£ 10.87) / (200 bar x 2610 L)<br>= £ 8.00 x $10^{-4}$ = 0.08 p | 0.08 p |
| He | Cost per cylinder = £ 133.93<br>Pressure of cylinder = 200 bar<br>Size of cylinder = 9.1 $m^3$ = 9100 L<br>Flow rate = 0.3 L $min^{-1}$<br>0.3 L $min^{-1}$ x 25.6 min x (£ 133.93) / (200 bar x 9100 L)<br>= £ 5.65 x $10^{-4}$ = 0.06 p | 0.06 p |
| $H_2$ | Cost per cylinder = £ 10.08<br>Pressure of cylinder = 120 bar<br>Size of cylinder = 1.48$m^3$ = 1480 L<br>Flow rate = 0.03 L $min^{-1}$<br>0.012 L $min^{-1}$ x 25.6 min x (£ 10.08) / (120 bar x 1480 L)<br>= £ 1.74 x $10^{-5}$ = 1.74 x $10^{-3}$ p | 1.74 x $10^{-3}$ p |
| Equipment | Elegoo Mars 2 3D Resin Printer = £ 179<br>Cetac Nebuliser (Used) = £ 600<br>Advanced Energy Cesar Generator = £5000<br>Harvard Syringe Pump (Used) = £ 350<br>Mass Flow Controller = £ 420 * 3 = £ 1260<br>Physik Intrumente (Used) = £ 110 * 3 = £ 330<br>Consumables (4 mm tubing and gas fittings) = £ 100 | 37.40 p |

| | | |
|---|---|---|
| | Total = £ 7819<br>Based on a 5 year lifetime and 223 working days<br>(5 day working week,<br>28 days holiday and 9 bank holidays)<br>Cost per day = £ 7.01<br>Based on an 8 hour working day<br>Cost per working hour = 87.66 p<br>Cost for 1536 second deposition = 37.40 p | |
| Borosilicate slide | Pack of 100 borosilicate slide = £ 2<br>Cost per borosilicate slide = £ 0.02 | 20.00 p |
| Resin | Cost of 1kg industry standard resin = £ 40<br>Mass of each plasma jet model = 21.9 g<br>Cost per model = £ 0.99<br>Based on a 30 day lifetime for each model<br>Cost per day = £ 0.03<br>Based on an 8 hour working day<br>Cost per hour = 0.41 p<br>Cost for 1536 s deposit = 0.18 p | 0.18 p |
| Silver nitrate | Cost of silver nitrate (250 g) = £ 334.42<br>Injection rate of 10 ml $hr^{-1}$<br>Concentration = 100 uM<br>Molar mass = 169.87 g $mol^{-1}$<br>0.01$dm^3$ x 1 x $10^{-4}$ M = 1 x $10^{-6}$ mol<br>1 x $10^{-6}$ mol x 169.87 g $mol^{-1}$ = 1.70 x $10^{-4}$ g in 10ml of solution<br>For 1536 second deposit 4.26 ml solution is needed<br>4.26 ml / 10 ml x 1.70 x $10^{-4}$ g = 7.24 x $10^{-5}$ g<br>7.24 x $10^{-5}$ g / 250 g x £ 334.42 = 9.69 x $10^{-3}$ p | 9.69 x $10^{-3}$ p |
| Total | 46.46 p excluding borosilicate slide | |

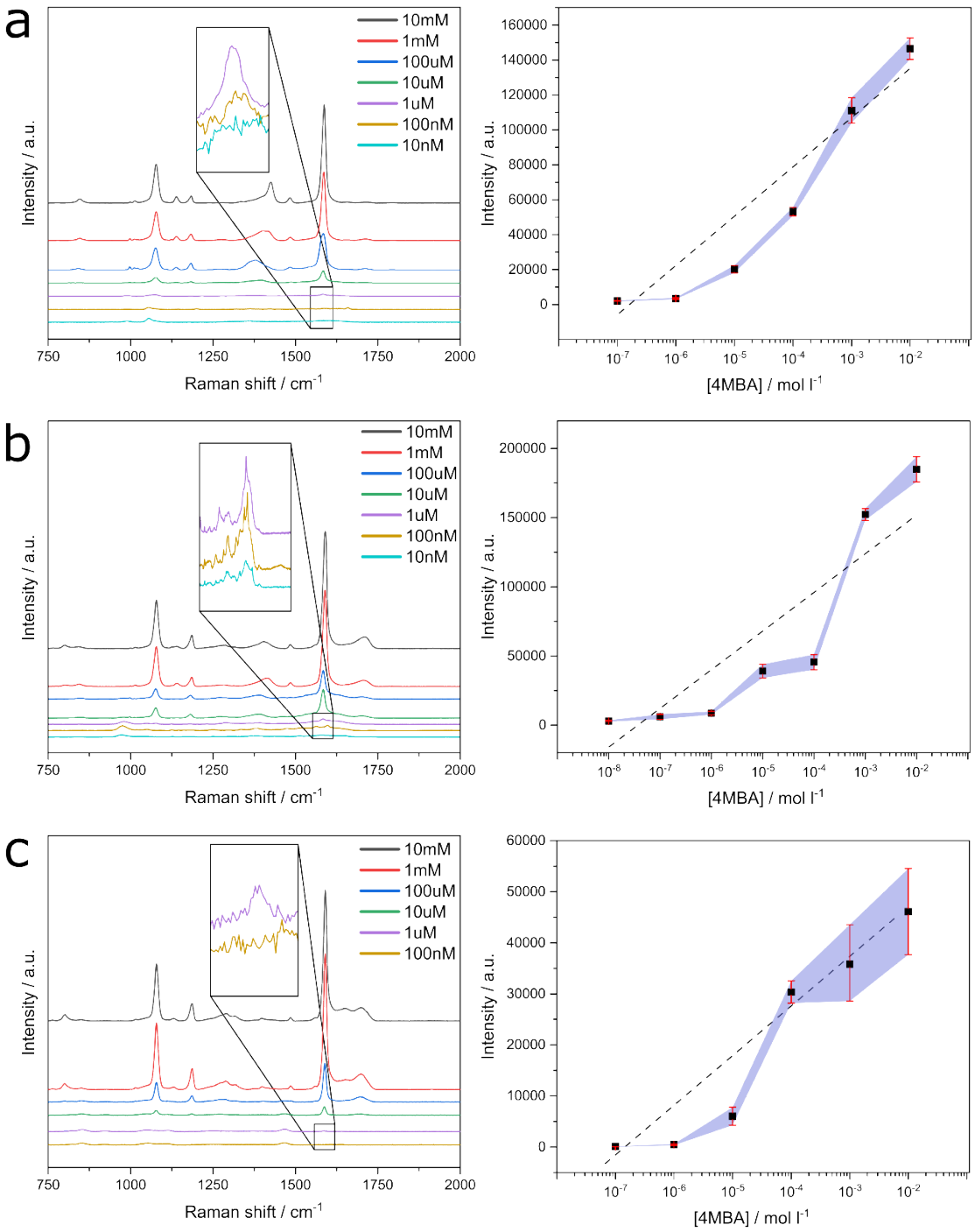


**Figure S2.** Normal Raman spectra of 4MBA between 100 nm to 100 mM for PSNP (a), SERSitive (b), OI (c) silver based SERS substrates and the corresponding concentration dependence of 4MBA of the Raman peak height at 1586 $cm^{-1}$ for between 1 x $10^{-8}$ M to 1 x $10^{-2}$ M.

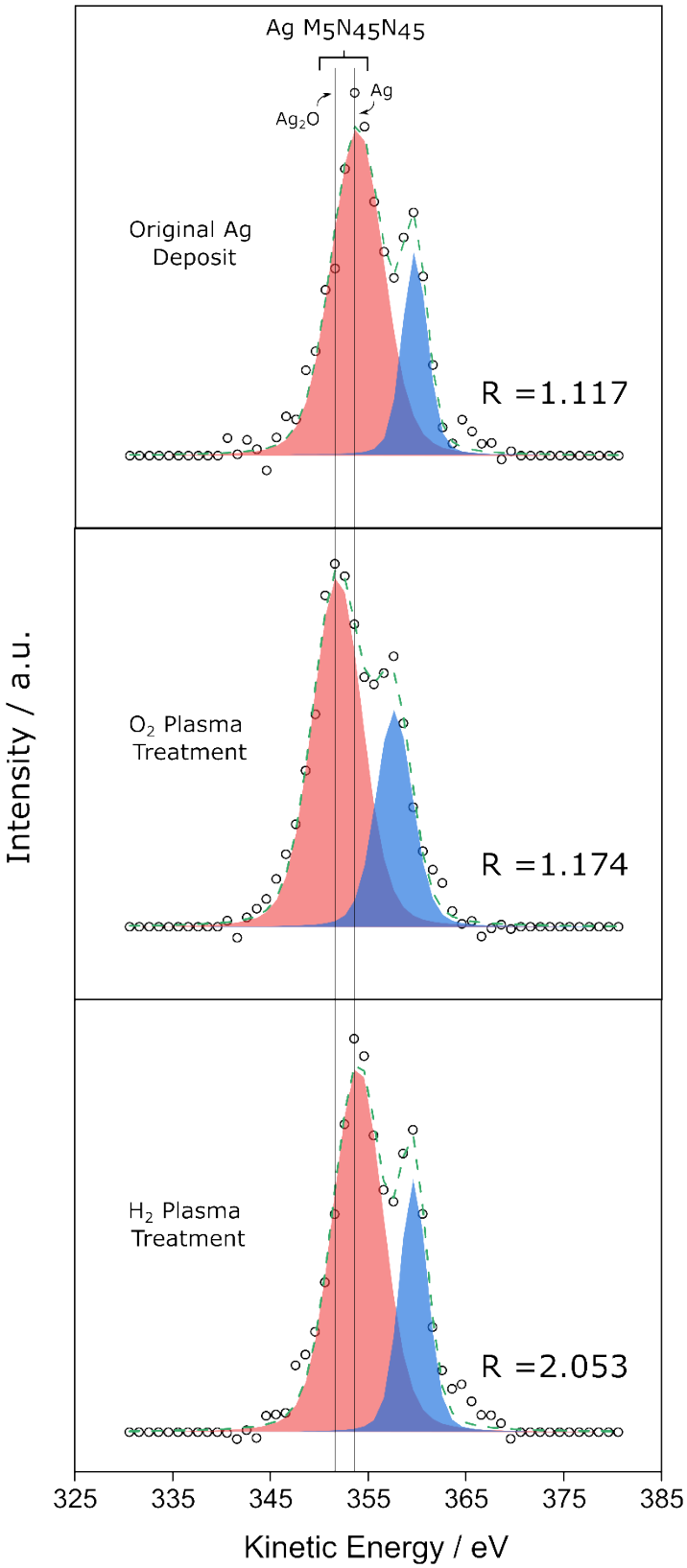


**Figure S3.** Carbon corrected (BE 284.8 eV) X-ray Photoelectron Spectroscopy (XPS) Ag MNN of plasma deposit and subsequent oxygen plasma treatment, and oxygen and hydrogen plasma treatment. All spectra were in agreement with Ferraria et al. [1]

# References

1. Ferraria, AM., et al., X-ray photoelectron spectroscopy: Silver salts revisited. Vacuum, 2012. **86**(12): p. 1988-1991.