Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Supplementary Information

1. Gold films deposited on various substrates

As the plasma jet is installed on a table-top CNC machine, it can print patterns specified by a CAD file or G code. Fig. S1 shows photographs of different features of gold films deposited on various substrates.

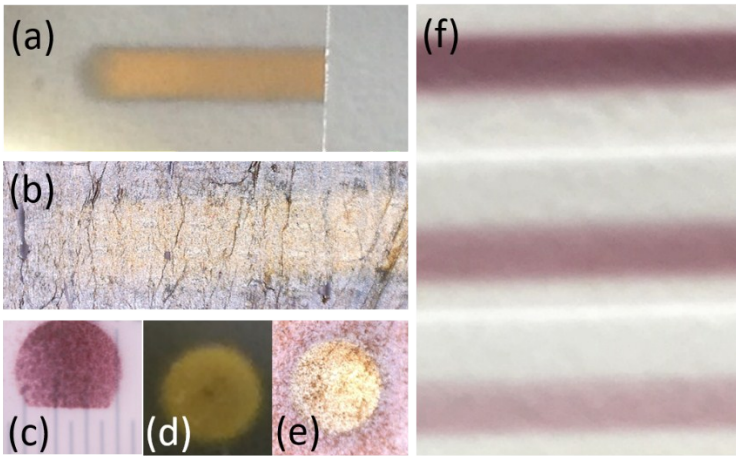

Fig. S1 Photos of nanogold film deposited on different substrates (a) glass (paper underneath), (b) graphene on PTFE membrane, (c) anodized aluminium oxide, (d) Si wafer, (e) nail-polish coated Whatman filter paper and (f) uncoated Whatman filter paper with different deposition time. The diameter of the deposited circular spots and the width of the deposited lines is approximately 2 mm

2. Photographs of plasma jet

The close-up image of the plasma jet shows more detail of the plasma printing process, with the deposited nanogold spot having a violet colour in Fig. S2 (a). The figure shows the relatively diffuse plasma discharge with decreased current density that occurs for a non-conducting substrate. In the case of a conductive substrate (Fig. S2 (b)), the plasma jet becomes more intense. The plasma parameters need to be adjusted to optimize deposition on a particular substrate.

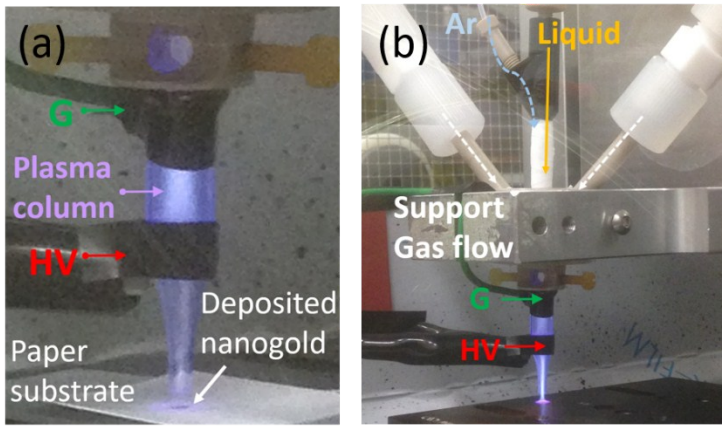

Fig. S2 Photos of plasma jet functioning as a nanogold printing head (a) close-up image of plasma discharge during Au deposition on photographic paper, and (b) deposition on anodized aluminium, reused from Fig. 1(b) for reference

3. XPS measurements of gold films deposited on different substrates

The Cl 2p spectra and detailed deconvolution results of Au4f spectra for the samples shown in Fig. 3 and 4 are given below.

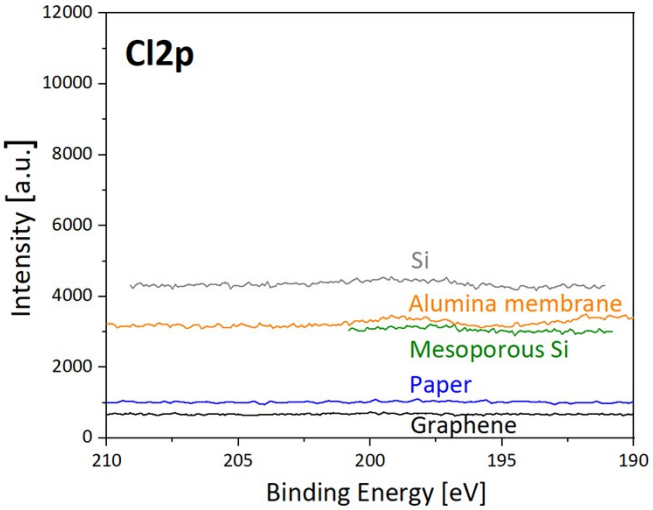

Fig. S3 XPS spectra of Cl2p on different substrates

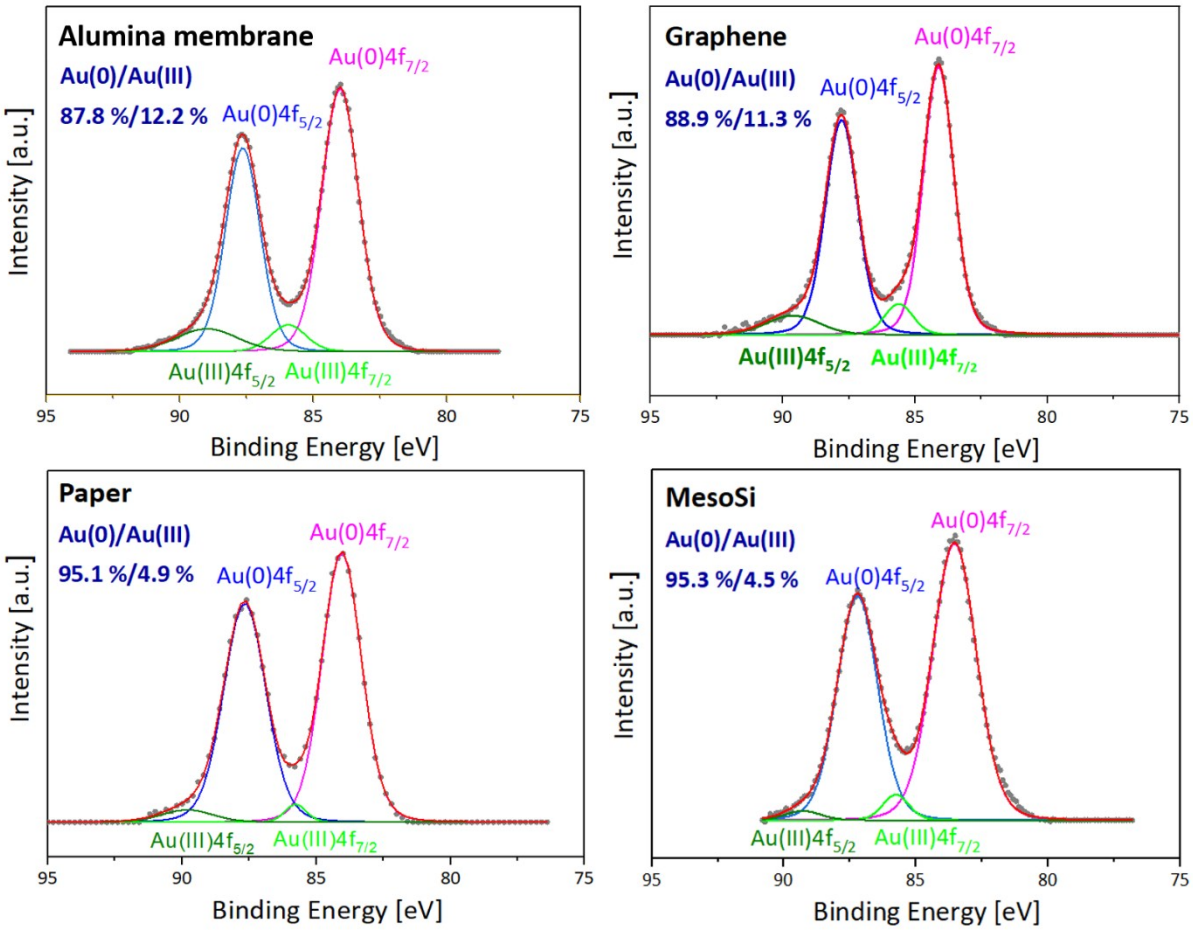

Fig. S4 XPS analysis spectra of Au4f peak for the different substrates shown in Fig. 3 and 4

4. Reproducibility test

The reproducibility test results of nanogold deposition for Si wafer and paper substrates are shown below in Fig. s5 –s8. The recent results generally show a small decrease in the thickness of the nanogold film. Individual measurements are within the experimental uncertainly, but the trend is consistent. Figure s5 shows two examples. For 2 min deposition time, the average thickness was previously 140 ± 21 nm, while the recent trial gave 116 ± 10 nm.

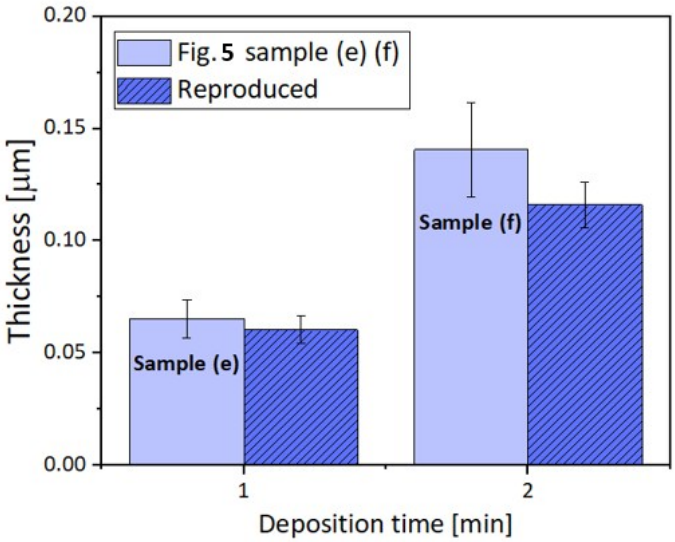

Fig. s5 Comparison of thickness measurements of nanogold film deposited on Si substrate

The SEM images were taken for the reproduced nanogold film and compared with the original SEM images shown in Fig. 5 in the manuscript. Figure s6 confirms a slightly slower film growth under the same conditions.

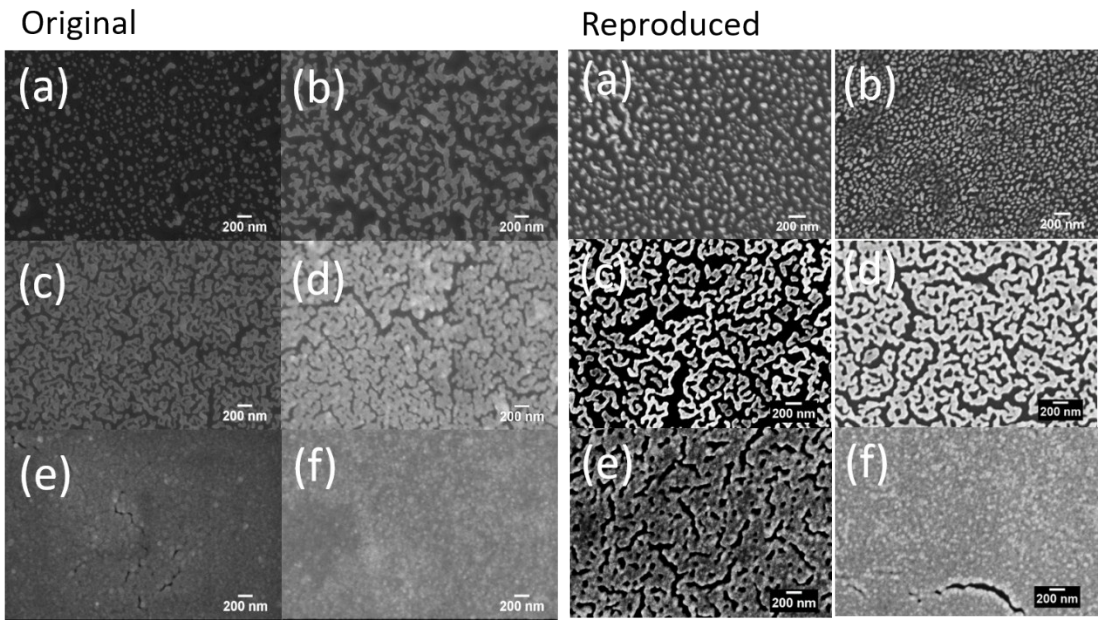

Fig. s6 Comparison of SEM images of nanogold film deposited on an Si substrate. The original results (Fig. 5 in the manuscript) are on the left and the recent results are on the right. Deposition times in each case were (a) 5 s, (b) 10 s, (c) 20 s, (d) 30 s, (e) 1 min and (f) 2 min.

SERS measurements were performed for each sample and showed acceptable reproducibility. The sensitivity declined more slowly with increasing deposition time for the reproduced samples, as expected based on the slower film growth, so detection of 10^{-5} M of RhB was possible even for the 1-min deposition time sample.

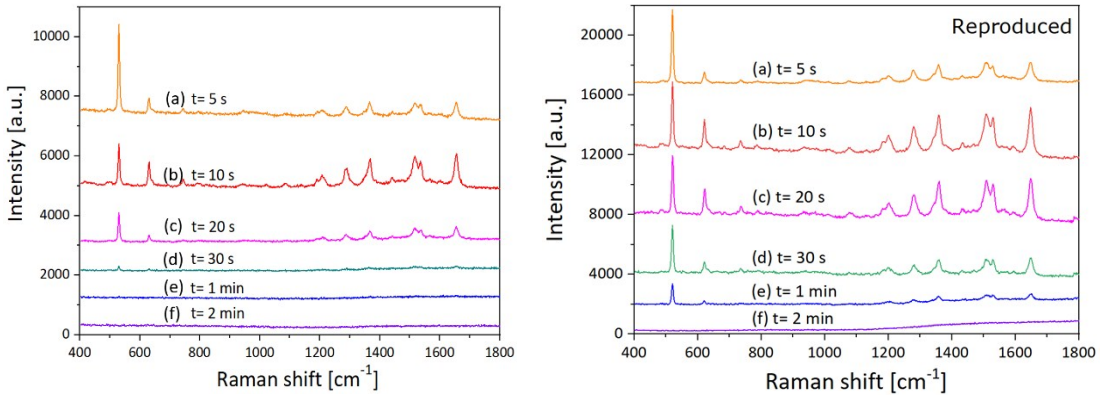

Fig. s7 Comparison of SERS measurement result of nanogold film deposited on a Si substrate. The original (Fig. 6 in the manuscript) are on the left and the reproduced results are on the right. Deposition times in each case were (a) 5 s, (b) 10 s, (c) 20 s, (d) 30 s, (e) 1 min and (f) 2 min.

Results for a paper substrate are given in Fig. s8, which shows a comparison of the SERS measurement results for two gold film samples. They were deposited under the conditions used for sample (d) in Fig. 7 of the manuscript. The measurements for each sample were taken in the central region of the sample at 16 different positions with 50 µm spacing. The test is therefore of both uniformity within a sample and reproducibility between samples. It is clear that both are acceptable.

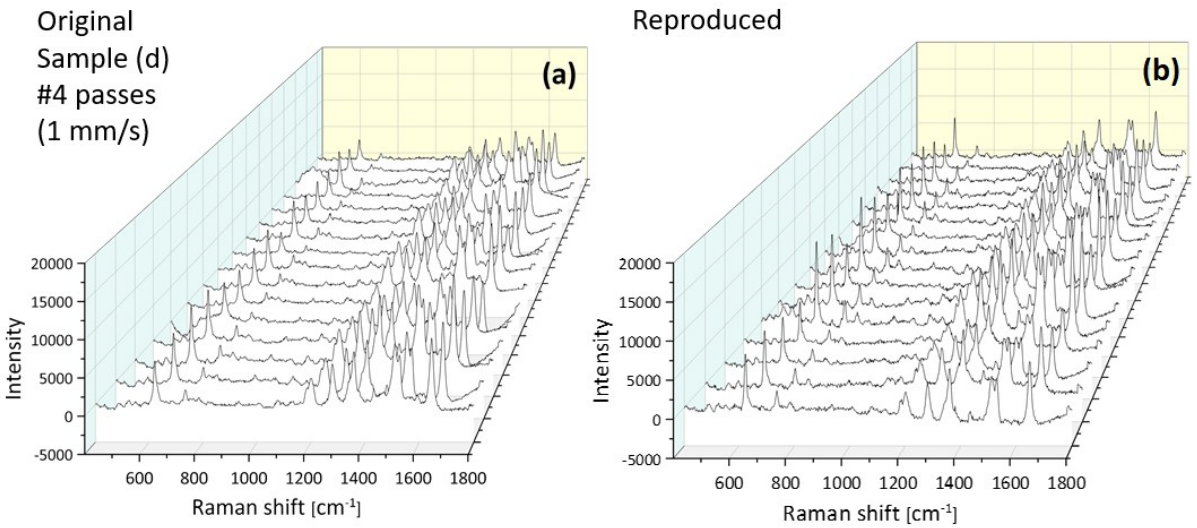

Fig. s8 Comparison of SERS measurement results at 16 different positions for nanogold film deposited with 30 s deposition time on a paper substrate; (a) original (Fig. 7, Sample (d) in the manuscript); (b) reproduced sample.