Supplementary Information

Environmentally friendly etching agent: vapor from hot electron-activated liquid water

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FIGURE CAPTIONS

Figure S1. Photo image showing the etching of glass by hot electron-activated (HEA) water vapor.

Figure S2. Cross-sectional SEM images of silicate glass sheets etched in atmospheres containing DI water or HEA water vapor at room temperature for 3 h. (a) A blank glass sheet without etching treatment was used for a reference. (b) An etched glass sheet based on DI water. (c) An etched glass sheet based on HEA water.

Figure S3. Photo image of a deionized (DI) water-wetted glass bottle (lower part near bottom) in direct contact with hot electron-activated (HEA) water for 3 h.

Figure S4. Contact angles measured on silicate glass sheets from (a) blank glass sheet without etching treatment was used for a reference, (b) etched glass sheet based on DI water and (c) etched glass sheet based on HEA water.

Figure S5. AFM images of high-grade silicate glass sheets, which are used in the photoelectric industry, etched by different methods. (a) A blank glass sheet without etching treatment was used for a reference. (b) Glass conventionally etched in 1 M of NaOH for 3 h. (c) Glass etched in an atmosphere containing hot electron-activated (HEA) water vapor at room temperature for 3 h.

Figure S6. AFM images of (a) a silicon wafer and (b) a silicon wafer etched in an atmosphere containing hot electron-activated (HEA) water vapor at room temperature for 3 h.

Figure S7. Zeta potential of HEA water.

Figure S8. Zeta potential of DI water.

Figure S9. SERS spectra of R6G with different concentrations (2×10^{-6} to 2×10^{-14} M) adsorbed on Au film-deposited (a) blank and (b) etched glass substrates.

Figure S10. UV-vis absorption spectra of Au film-deposited blank and etched glass substrates. Measurements were performed at three different spots on the same substrate.

Figure S11. Calculated relative standard deviations (RSDs) based on SERS intensities of R6G of the strongest bands (at ca. 1506 cm^{-1}) at three selected spots on the same Au film-deposited blank and etched glass substrates in three different batch experiments. The etching experiment was performed in an atmosphere containing hot electron-activated (HEA) water vapor at room temperature for 3 h, and the corresponding SERS spectra of 2×10^{-6} M R6G adsorbed onto them were recorded.

Figure S12. Optical microscopic images of crosshatch examinations of crosscut adhesion tests of 20-nm Au films deposited on silicate glass sheets without etching and with etching (before Au deposition) in an atmosphere containing hot electron-activated (HEA) water vapor at room temperature for 3 h. (a), (b), and (c) Au films deposited on blank glass sheets. (d), (e), and (f) Au films deposited on etched glass sheets.

Figure S1

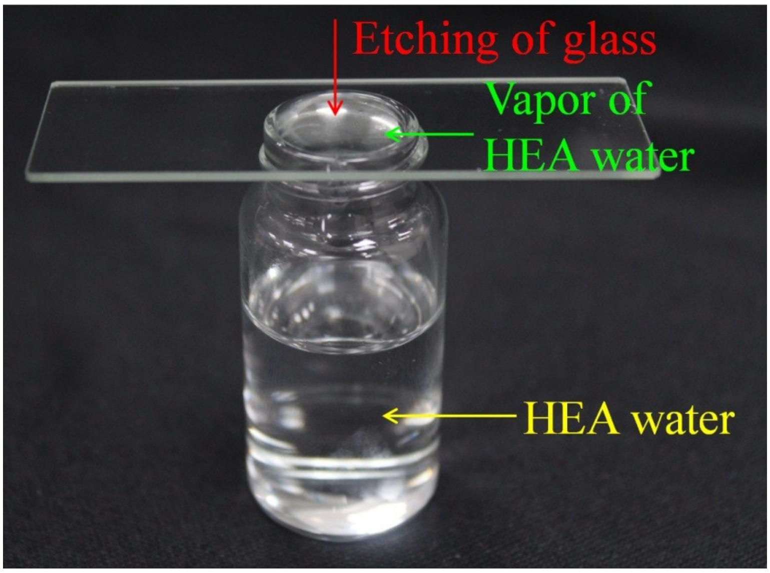


Figure S2

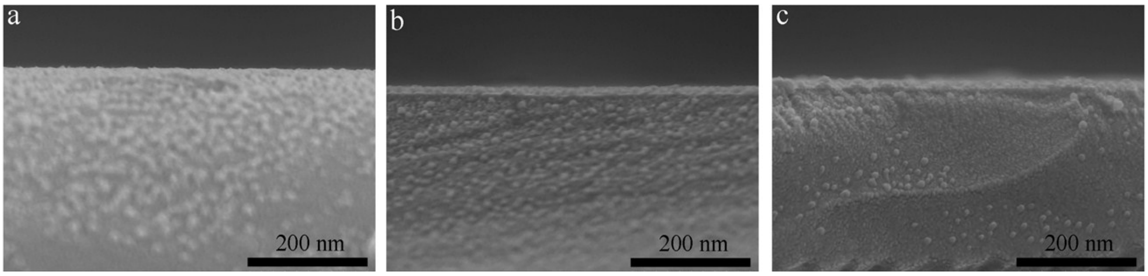


Figure S3

Figure S4

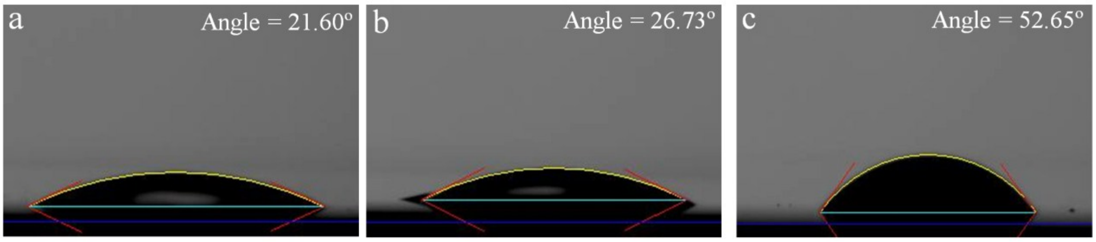


Figure S5

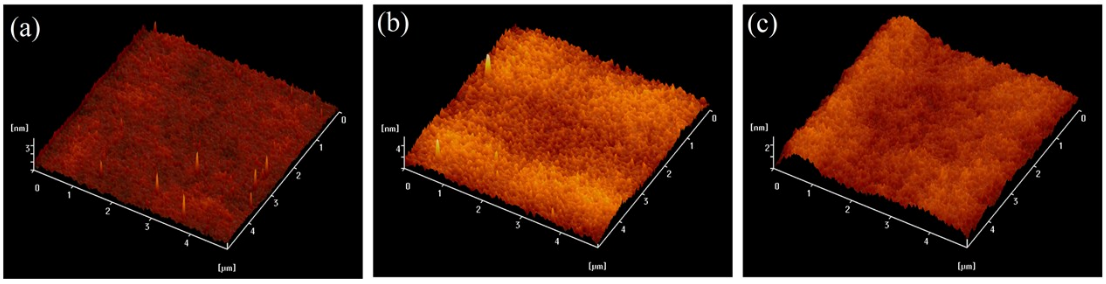


Figure S6

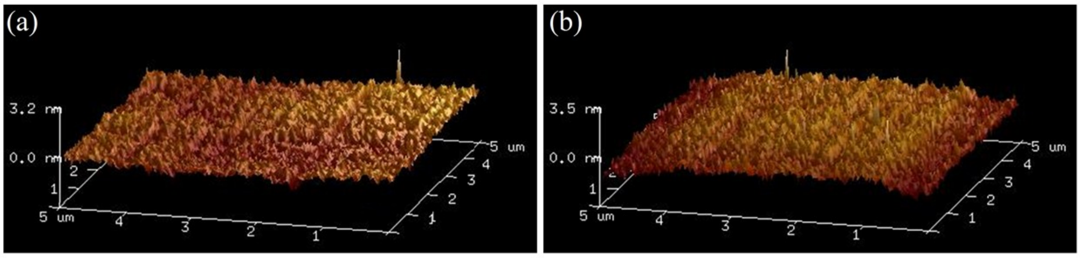
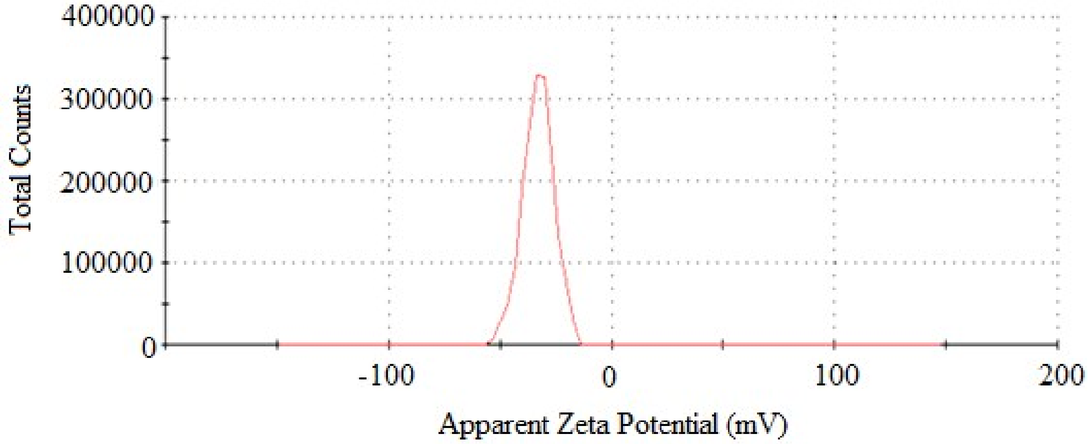
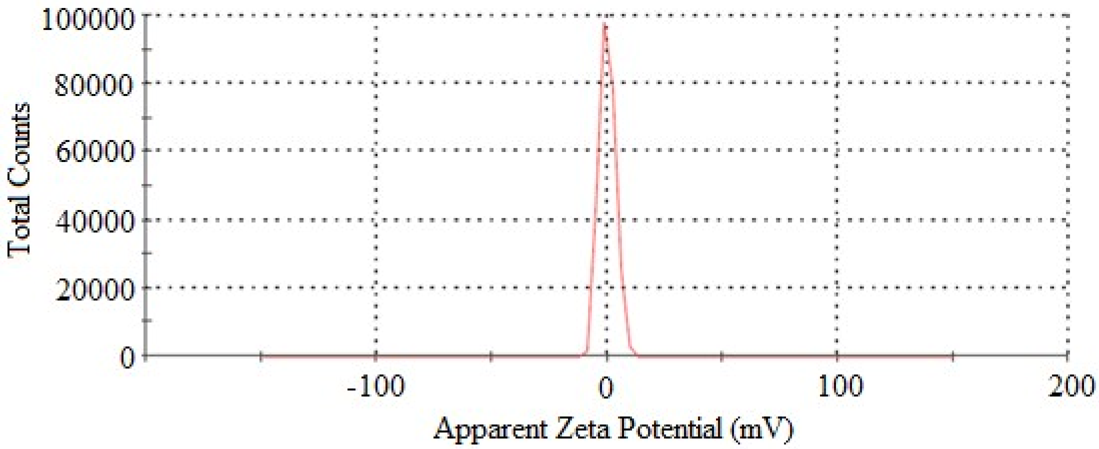


Figure S7



400000
300000
200000
100000
0
Total Counts
-100
0
100
200
Apparent Zeta Potential (mV)

Figure S8



100000
80000
60000
40000
20000
0
Total Counts
-100
0
100
200
Apparent Zeta Potential (mV)

Figure S9

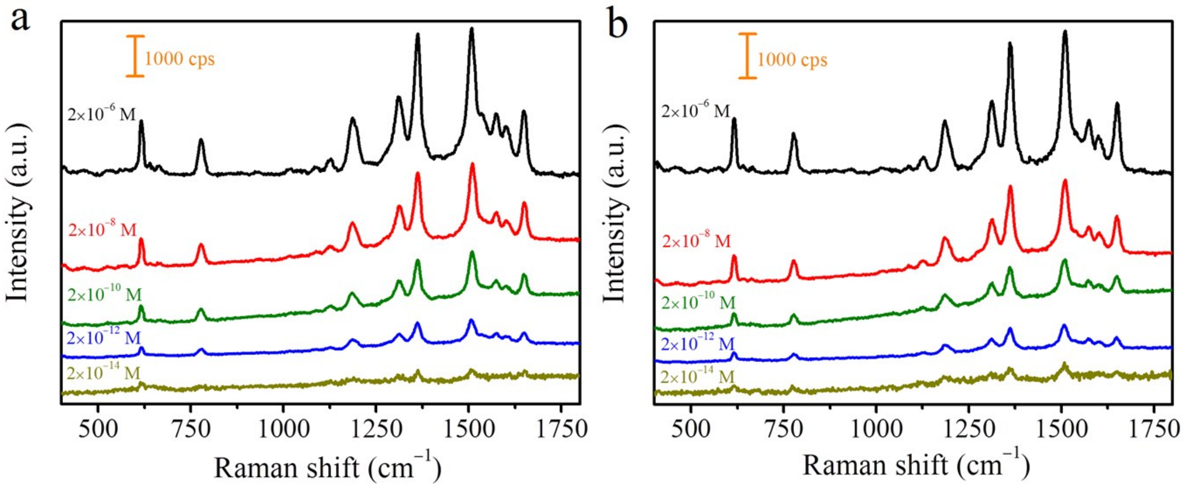
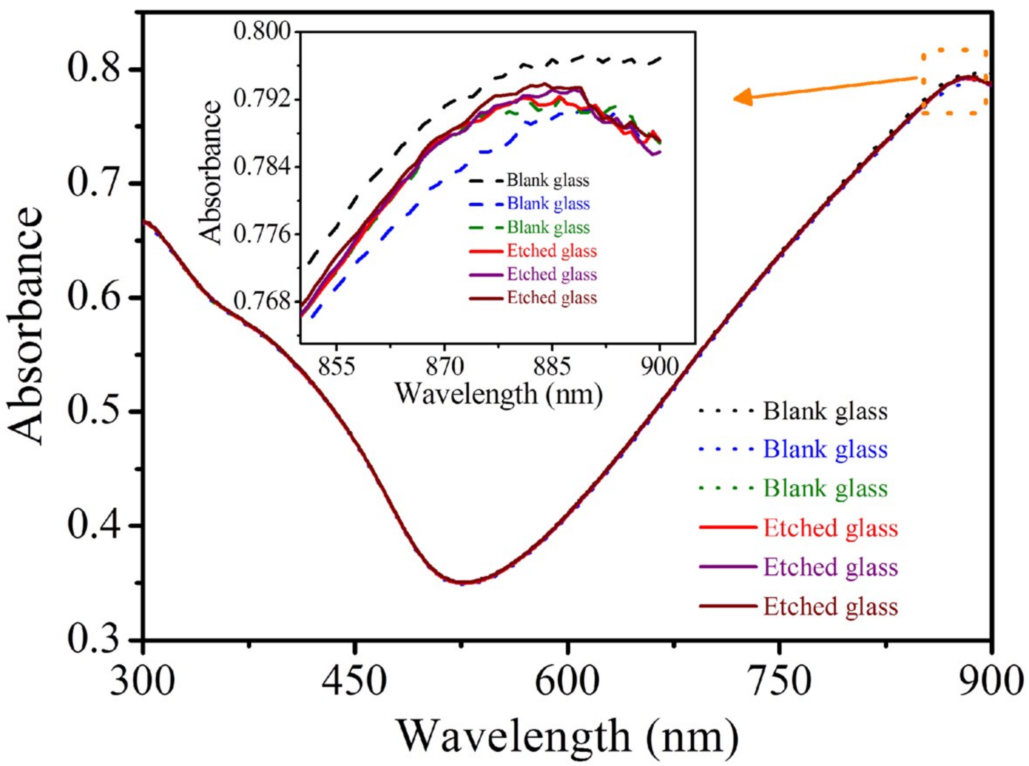
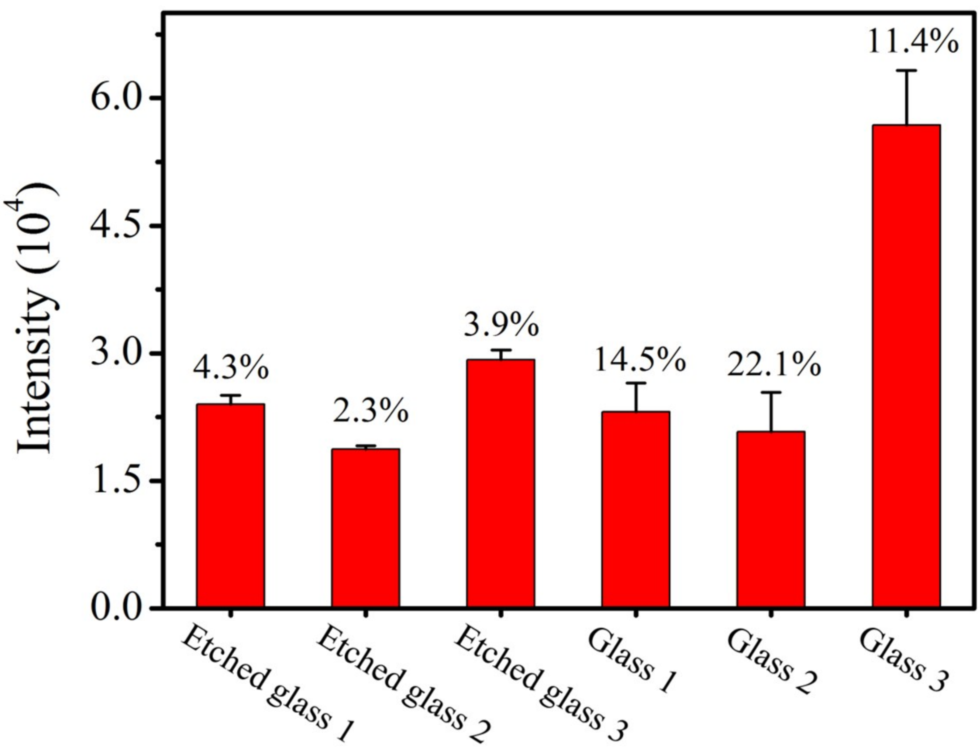

a
1000 cps
2×10⁻⁶ M
2×10⁻⁸ M
2×10⁻¹⁰ M
2×10⁻¹² M
2×10⁻¹⁴ M
Intensity (a.u.)
Raman shift (cm⁻¹)
500
750
1000
1250
1500
1750
b
1000 cps
2×10⁻⁶ M
2×10⁻⁸ M
2×10⁻¹⁰ M
2×10⁻¹² M
2×10⁻¹⁴ M
Intensity (a.u.)
Raman shift (cm⁻¹)
500
750
1000
1250
1500
1750

Figure S10



0.800
0.792
0.784
0.776
0.768
Absorbance
855
870
885
900
Wavelength (nm)
Blank glass
Blank glass
Blank glass
Etched glass
Etched glass
Etched glass
0.8
0.7
0.6
0.5
0.4
0.3
Absorbance
300
450
600
750
900
Wavelength (nm)
Blank glass
Blank glass
Blank glass
Etched glass
Etched glass
Etched glass

Figure S11



Intensity (10^4)
6.0
4.5
3.0
1.5
0.0
4.3%
2.3%
3.9%
14.5%
22.1%
11.4%
Etched glass 1
Etched glass 2
Etched glass 3
Glass 1
Glass 2
Glass 3

Figure S12