**Supporting Information**

**Metal Nanoparticle Decorated Silicon Nanowire Array on Silicon Substrate and Their Applications**

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Picture1.tif

**Figure S1.** (a) Formation of Si nanowire on planar Si using 0.2M H2O2 as etchant (b) HRTEM image (c) Wien filtered HRTEM image of a single nanowire showing absence of any amorphous Si layer. (d) FFT pattern of the region shown in (c) showing very good crystalline structure of the nanowire.

**Picture3.tif**

**Figure S2.** HAADF-STEM image of Si nanowire on pyramidal Si

Picture2.tif

**Figure S3.** (a) HRTEM image from the interface of Ag and Si. (b) Wien filter image of the marked portion from (a) showing presence of crystal plane between Si and Ag. (c) HAADF-STEM image (d) EDX line scan taken along the arrow direction shown in (c) showing increment in the O-K signal from the interface.

**SERS CALCULATION**

SERS enhancement factor, EF = [(ISERS) / (IBulk)] × [(NBulk)] / (NSERS)],

where, ISERS is the integral intensity of a certain vibrational mode (Raman peak) of the analyte in the presence of nanoparticles, and IBulk is the intensity of the same in the bulk Raman spectrum from the analyte alone (10-1M R6G on Planar Si(100)).

NBulk is the number of molecules used in the bulk, and NSERS is the number of molecules adsorbed and sampled on the SERS-active substrate.

NBulk = [(Confocal volume × Density)/ (Molecular weight)]× Avogadro’s Number (NA)

The term confocal volume describes the volume within the full width half-maximum of the point spread function in x, y and z. If we approximate the volume with a function of a 3D Gaussian shape, the confocal volume comes out as (π/2)3/2 times the effective volume, which can be written as

τ = (π/2)3/2.

Where the outgoing radiation is considered to be of 3d Gaussian nature which decays to 1/e2 at in lateral direction and in axial direction. So, the factor 3/2 comes from integrating the Gaussian spread function for outgoing radiation in 3 dimensions.

The beam diameter and focal depth mentioned in the calculation of EF is dependent of numerical aperture (N.A) and incident wavelength and are given as follows:

Laser spot diameter, W0 = 1.22λ/Numerical Aperture (N.A); Focal depth, Z0 = (2π/λ) W02

Assuming R6G molecules deposited on patterned Si uniformly, number of molecules NSERS was considered to be the total number of molecules on the substrate to the fraction which falls within the laser spot area.

NSERS = [Laser spot area/Substrate area] × [Avogadro’s Number (NA)× Volume (V) × Concentration(C)]

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where, λ = Wavelength of the laser light (nm) = 632.8

NA= Numerical Aperture = 0.9 (100×)

*ρ* = Density of the analyte crystal (g cm-3)= 1.26

*A* = Area of the film (cm2)= 1

*w* = Weight of the analyte present in the solution spread on the film (ng)= 479.02

Hence, NBulk/NSERS = 4.816×103

**Table S1**. Enhancement factor (EF) from SERS measurement for different Raman peak of 1×10-5M R6G.

|  |  |  |  |
| --- | --- | --- | --- |
| **Raman**  **Peaks (cm-1)** | **EF of P-Si/ NW Si** | **EF of P-Si/ NW-Si and Ag N2 annealed** | **EF of P-Si/ NW-Si and Ag O2 annealed** |
| 609 | 7.5 × 104 | 1.1 ×105 | 1.5×105 |
| 775 | -- | 1.2× 104 | 1.05× 104 |
| 1187 | -- | 3.1× 104 | 3.2× 104 |
| 1305 | -- | 3.5× 104 | 3.4× 104 |
| 1360 | 1.08×105 | 1.7× 105 | 2.08× 105 |
| 1572 | 1.62×105 | 2.3× 106 | 2.6× 106 |