Electronic Supplementary Material (ESI) for Nanoscale.
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Supporting Information

Gold nanoparticles-ultrananocrystalline diamond hybrid structured materials for high-performance optoelectronic device applications

Kamatchi Jothiramalingam Sankaran,[a] Srinivasu Kunuku,[b] Balakrishnan Sundaravel,[c] Ping-Yen Hsieh,[a] Huang-Chin Chen,[d] Keh-Chyang Leou,[b] Nyan-Hwa Tai,*[a] and I-Nan Lin*[d]

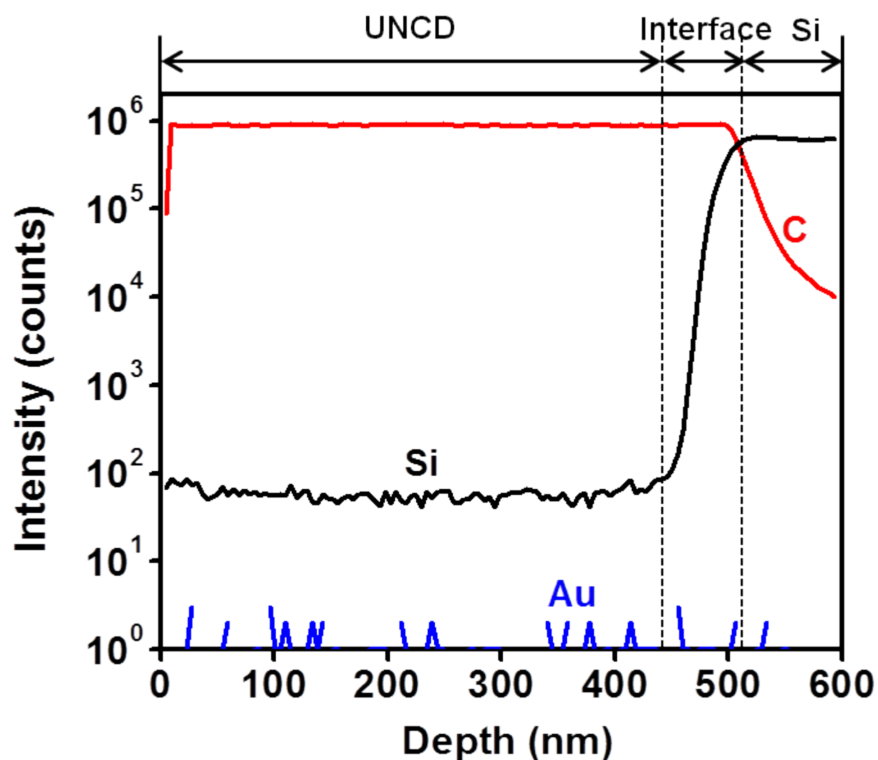

Figure S1. SIMS depth profiles of C, Au, and Si species in UNCD/Si materials.

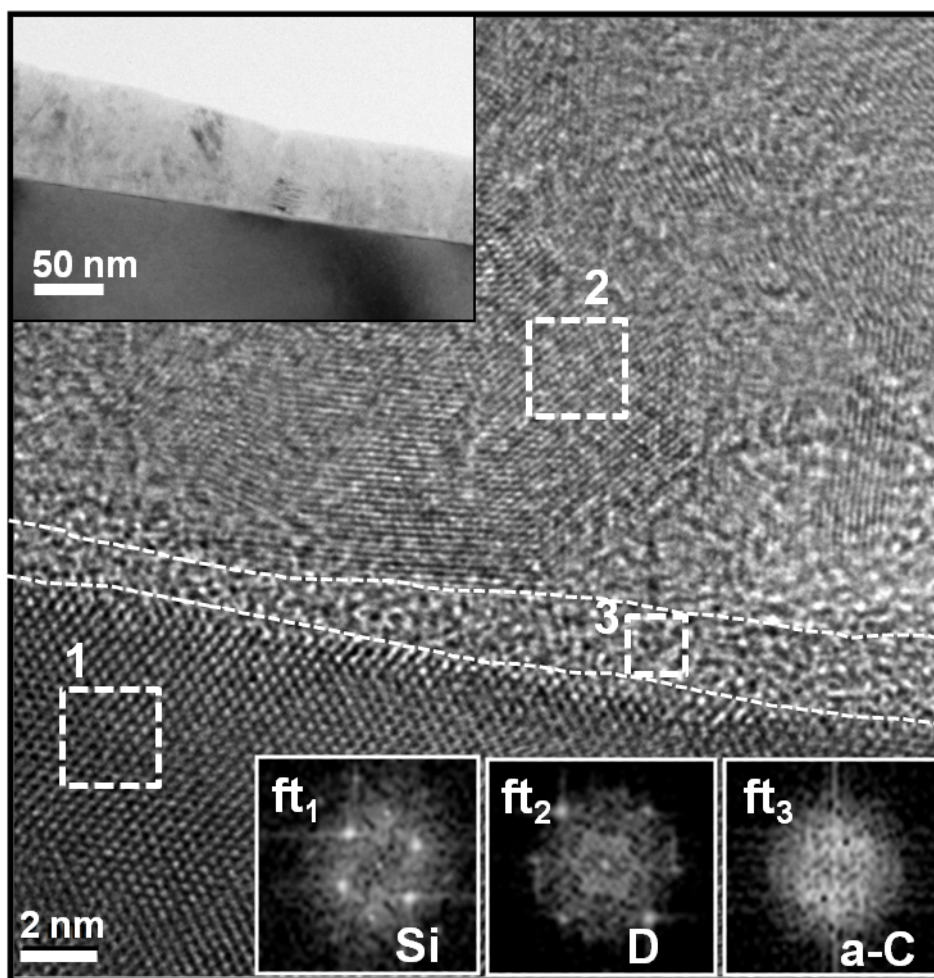

Figure S2. High magnification HRTEM image with upper-left inset shows the low magnification TEM image of UNCD/Si materials. FT patterns of the corresponding regions marked 1, 2, and 3 in the HRTEM image are shown in the insets ft_1, ft, and ft_3, respectively.

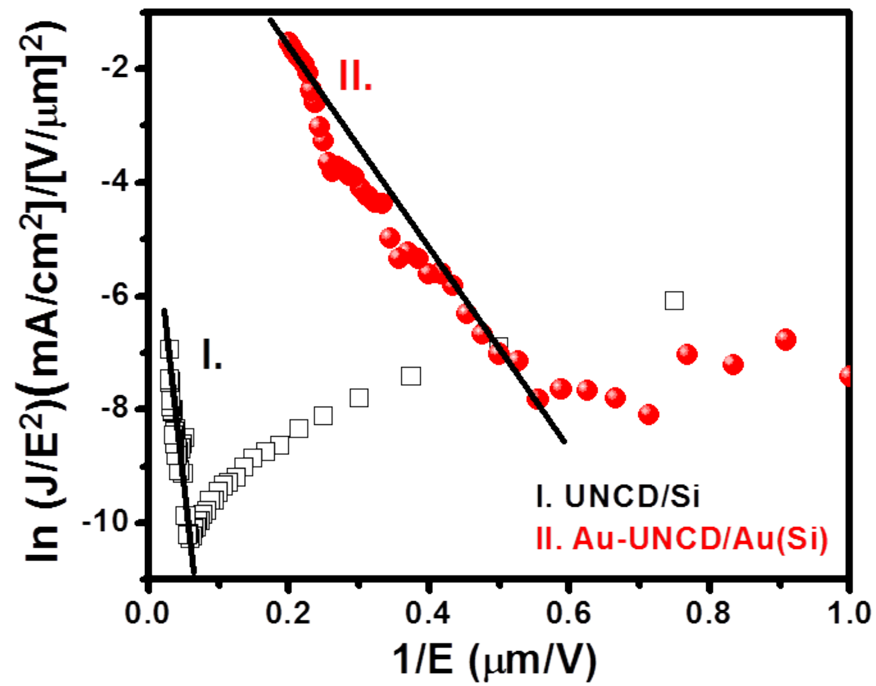

Figure S3. (a) The F-N plots of the corresponding J_e-E characteristic curves, which were used for evaluating the effective work function of the emitting materials: I. UNCD/Si and II. Au-UNCD/Au(Si) hybrid materials.

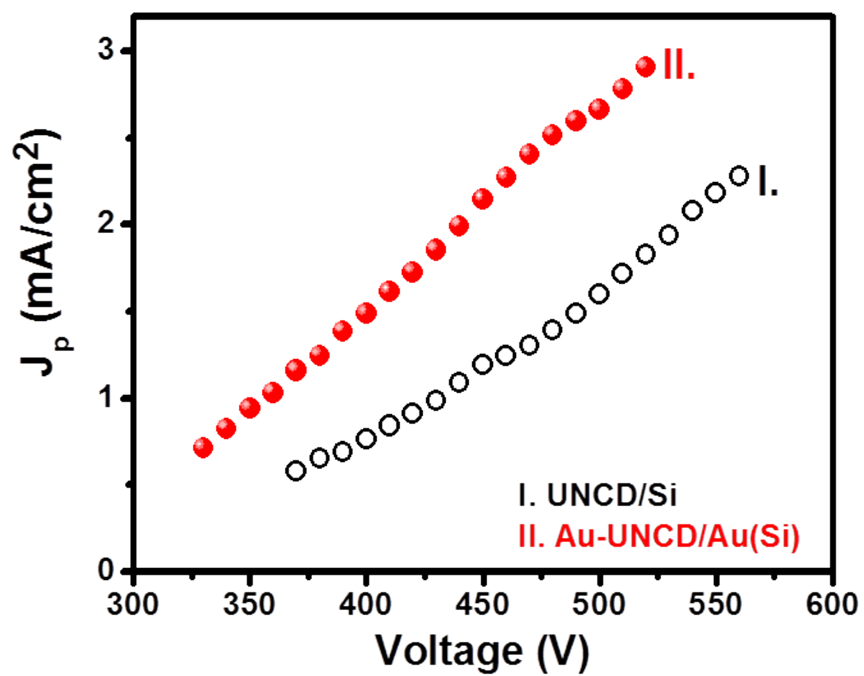

Figure S4. The plasma density against applied field curves, which were used for calculating the plasma density for the microplasma devices using for I. UNCD/Si and II. Au-UNCD/Au(Si) hybrid materials as cathode materials.

Estimation of plasma density (n_p) from plasma current density (J_p):

We have estimated the plasma density (n_p), which is also the electron density (n_e), in the plasma, by using the Child's Law, shown in equation 2.[1]

$$n_e = \frac{J_c}{eu_B} \text{ --------------------------------- (2)}$$

Here n_e is the electron density, J_p is plasma current density at cathode, e is the electron charge and μ_B is the Bhom velocity. Bhom velocity of Ar ion is strictly depends on the kinetic energy of the electron and the mass of ion, which has described as below equation 3.[2]

$$u_B = \sqrt{\frac{kT_e}{m_i}} \text{ ------------------------------ (3)}$$

Here k is the Boltzmann constant and T_e is electron temperature is 7841 K.[3] By substituting the Bohm velocity in the equation 1, we can attain the complete equation for estimation of electron density, shown below equation (4).

$$n_e = \frac{J_c\sqrt{mi}}{e\sqrt{kT_e}} \text{ --------------------------------------- (4)}$$

1 M. A. Lieberman and A. J. Lichtenberg, *Principles of Plasma Discharges and Materials Processing*, 2nd Ed; John Wiley & Sons:Hoboken, NJ, USA 2005.

2 B. Chapman, *Sputtering and Plasma Etching*, John Wiley & Sons, New York, USA 1980.

3 K. Srinivasu, K. J. Sankaran, K. C. Leou, N. H. Tai and I. N. Lin, *Plasma Sources Sci. Technol.* **2014** (Submitted).