Supporting information

Investigation on resistivity-dependent behavior of carbon composite-based paintable ionovoltaic device

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Fabrication of the carbon composite ionovoltaic device: Conductive hardwood charcoal (80 mesh), poly(vinylidene fluoride-co-hexafluoropropylene) (Sigma Aldrich), octadecjyltrichlorosilane (Sigma Aldrich), and N-methyl-2-pyrrolidone (Daejung) were mixed in the portions mentioned in manuscript. The mixing ratios of the surfactants were determined to the extent that the surfactant was not the main constituent of the matrix. When BTO nanoparticles is added at a ratio of 0.05, when x = 2.8, the resistivity of the film is ~102k Ω·cm. Above the ratio of 0.05, the resistivity of the film increases abruptly (open circuit). Therefore, a mixing ratio of BTO nanoparticles less than 0.05, which improves adhesion but does not significantly change resistance, is adopted. Thereafter, the mixture was evenly dispersed using a homogenizer (1000 rpm, 10 min). Film was coated using a bar coater to make a thin-film carbon composite ionovoltaic device. For three-dimensional surface (Fig. S5b), the film was painted by brush. The coated thin film was completed by heating at 120 degrees for 20 minutes. Here, the thickness, resistance and adhesion properties of the carbon composite ionovoltaic device are determined sensitively by the concentration of mixture, coating conditions, annealing temperature, and the surface property of substrate.

Characterization of the carbon composite ionovoltaic device: Keithley 2182A nanovoltmeter and 6485 picoammeter were used to measure the output voltage and current of the device. The morphology of the carbon composite surface was investigated using a field emission scanning transmission electron microscope (S-4800, Hitachi). Raman spectrum was obtained using Raman spectrometer (DXR2xi, Thermo Scientific). Zeta potential was measure using zeta potential analyzer (ELSZ-2000, Otsuka Electronics Co.) using 1 mM NaCl solution (pH=6.3).

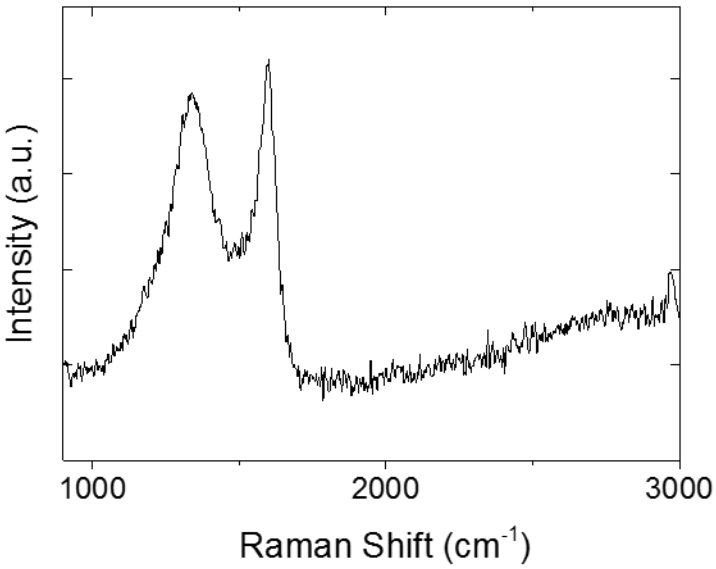

Figure S1. Raman spectrum of the carbon composite film.

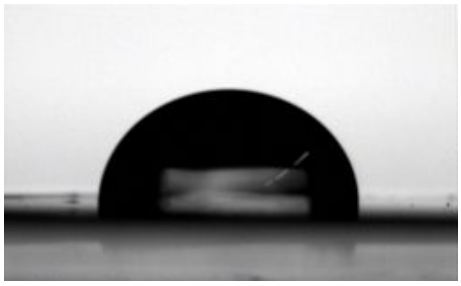

Figure S2. Image of contact angle measurement. The contact angle of the composite surface is about 90 degrees.

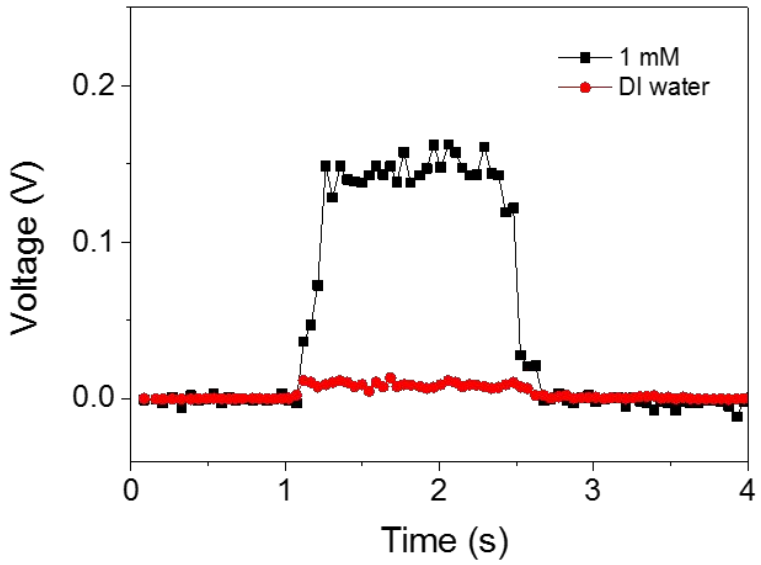

Figure S3. Measured output voltage using flowing droplets with 1 mM NaCl solution and de-ionized (DI) water.

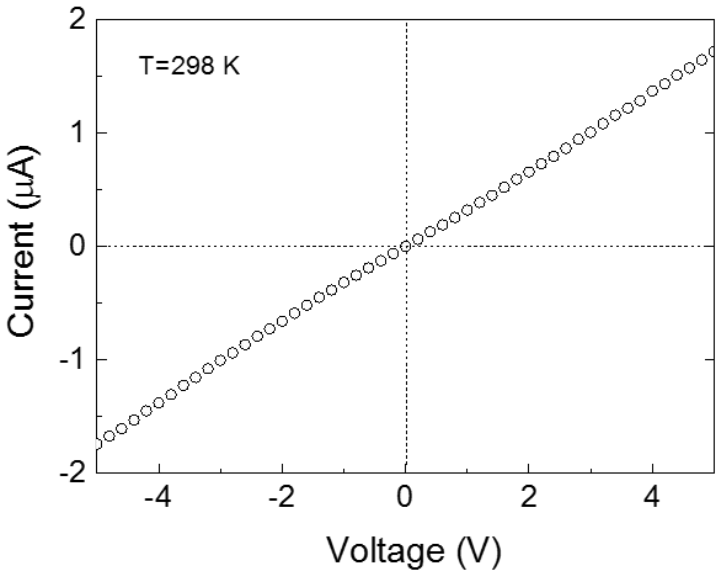

Figure S4. The current measured according to the voltage applied to the carbon composite film.

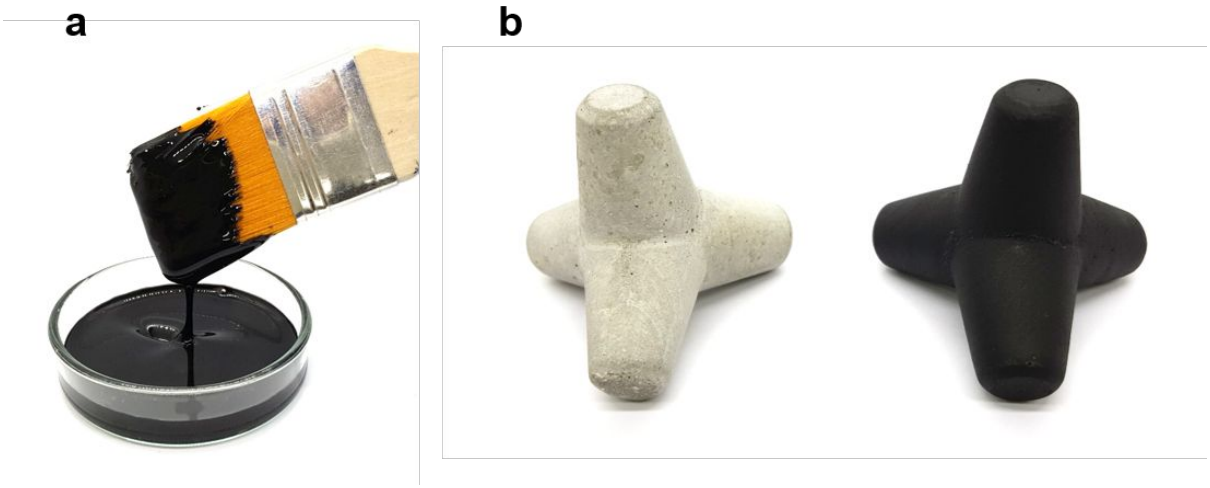

Figure S5. (a) Picture of a paint made of carbon composite mixture. (b) Three-dimensional structure (tetraport) photograph before (left) and after (right) coating of carbon composite. The height of tetraport model is 7 cm.