Supporting Information for

Janus Structured Multi-Walled Carbon Nanotube Forests: Simple Asymmetric Surface Functionalization at the Nanoscale

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Figure S1. Schematic representation of the liquid-liquid approach and MWCNT growth on a silicon substrate.

Figure S2. Schematic representation of the liquid-gas approach and MWCNT growth on a silicon substrate.

Figure S3. SEM images of Janus structured multi-walled carbon nanotubes.

Figure S4. (a) Optical microscope image obtained with a x50 lens for a MWCNT forest with a change in composition. The forest shows a section of un-doped MWCNTs (C) on top of a section made of N-MWCNTs (N). (b) Associated Raman spectra taken in each sections in the areas represented by dark and red spots in (a).

Figure S5. Schematic representation of vertically aligned (a) MWCNT, (b) N-MWCNT (c) MWCNT forests with C_1/N_2 intra-tubular junctions and (d) MWCNT forests with N_1/C_2 intra-tubular junctions obtained by a root-growth mechanism.

Figure S6. Energy dispersive X-ray spectroscopy (EDS) maps of iron (from residual catalysts particles, purple, intensity of peak at 6.399 keV) on various as-synthesized structures obtained by the liquid-gas approach for (a) C_1/C_2 , (b) N_1/N_2 , (c) C_1/N_2 and (d) N_1/C_2 structures. The part of the MWCNT grown first is on the left of each image. The iron-based catalyst particles line

indicating the interface is especially marked for the N₁/C₂ structure (d). Vertical arrows indicate the expected interface according to related morphological change observed on back-scattered images used to define EDS mapping zones.

Figure S7. SEM micrographs of the N root of a C_{1-liq}/N_{2-liq} MWCNT forest. Catalyst particles were originally deposited during the synthesis of the C section of the forest (toluene+ferrocene precursor) since no catalyst precursor was introduced during the time the N section was grown from benzylamine without ferrocene. (a) Catalyst particles from which MWCNTs have been disconnected. (b) Root of the N-MWCNT in the N section originally connected to the catalyst particles. (c) N-MWCNTs in the N section still connected to the catalyst particles.

Figure S8. Localized oxidative behavior of MWCNTs with intra-tubular junction. (a and b) SEM micrographs after oxidation of a N₁/C₂ structure at 520 °C for 30 minutes. (c) SEM micrograph of C₁/N₂ structure after 30 minutes oxidation in air at 520 °C. MWCNTs in (a) and (b) were obtained by the liquid-gas approach. MWCNTs reported in (c) were obtained by a liquid-[liquid+gas] approach where the N section was obtained using ammonia (gas) together with toluene (liquid) as precursor.

Figure S9. Localized oxidative behavior of MWCNTs with intra-tubular junction. SEM micrographs of C₁/N₂/C₃ MWCNT forest (a) before and (b) after oxidation at 520 °C for 30 minutes. Carbon nanotubes were obtained by using a liquid-[liquid+gas]-gas approach using respectively toluene, toluene and ammonia, and finally acetylene as precursors.

Figure S10. SEM micrographs of platinum particles electrodeposited on a $C_{1\text{-liq}}/N_{2\text{-liq}}$ MWCNT structures. The particles coverage differs from the (a) C and the (b) N section of the forest.

Figure S11. Platinum (green, intensity of peak at 2.100 keV) EDS maps of (a) C₁-liq/C₂-gas, (b) N₁-liq/N₂-gas, (c) N₁-liq/C₂-gas structures after chemical reduction of a platinum salt. The white arrows mark the expected interface between the N and C sections established by analysis of the backscattered electron micrographs used to record the EDS data.