**ADDITIONAL INFORMATION**

**Mercury goes Solid at room temperature at nanoscale:**

 **Towards an effective Hg waste storage**

**1. Synthesis of Hg Nanoparticles & their space confinement in BN host matrix**

The considered precursor was mercury (II) acetate Hg (C2H3O2)2 while Ortho-Boric acid “H3BO3” and Urea “H2NCONH2” were considered as a source for the host matrix of turbostratic BN.

The chemical reaction taking place was:

2H3BO3 + 1H2NCONH2  + ξHg (C2H3O2)2 →ξHg + 2BN + # Gases

While the H3BO3 and H2NCONH2 initial compositions were kept stoichiometric, the Hg (C2H3O2)2 was varied so to obtain nano-Hg particles within the final BN host matrix. The relative molar initial concentration to BN matrix of Hg (C2H3O2)2 was varied accordingly. Smaller is this molar concentration, smaller would be the nano-Hg’s size. The different solutions of H3BO3, H2NCONH2 and Hg(C2H3O2)2 , with the molar fraction of 2,1 and ξ where “ξ” was varied from 1, 1/4 and 1/20 for Hg (C2H3O2)2 in de-ionized H2O were prepared at room temperature. The corresponding samples are labeled as: Hg1/1-BN, Hg1/4-BN, Hg1/20-BN.

Following a thorough homogeneous steering, the solutions were sprayed individually in liquid Nitrogen through a nozzle of ≈1μm in diameter under an external pressure of Nitrogen carrier gas. The entire spray process took place for about 5 to 10 min for each experiment. The 3 different frozen solutions consisted of white ultra-porous networks. Each open frozen arrangement was transferred to a standard freeze-drying system where it went through a gradual sublimation phenomenon from ≈78°K to 298°K in vacuum. During such a gradual stage, the solid solvent “solid H2O” was taken off through a sublimation process. The final dried product consisted of an homogeneous mixture of the 3 initial salts of H3BO3, H2NCONH2 & Hg(C2H3O2)2 but in an ultra-porous form. Before the decomposition phase to obtain Hg particles embedded in BN host matrix, Differential Scanning Calorimetry “DSC” as well as thermogravimetry analysis were conducted. The DSC experiments were carried out in the temperature range of 25-400°C under pure Argon gas flow to locate the optimal temperature of decomposition of the triple precursor ultra-porous powders so as to minimize the temperature of decomposition in the furnace. Figure AI.1 shows the corresponding DSC profiles of the 3 original precursors labeled as Hgξ-BN with ξ =1/1,1/4 and 1/20. They exhibit mainly the typical different endothermic peaks of the chemical reaction of H3BO3 and H2NCONH2 to form the BN host matrix as well as the decomposition of the Hg(C2H3O2)2. Taking into account the thermogravimetry analysis and the present DSC measurements, the temperature corresponding to full decomposition was fixed at approximately ~250°C. The decomposition of the 3 ultra-porous precursors was performed by placing them in a quartz boat placed in a sealed quartz tube placed in a furnace under a continuous flow of pure hydrogen “99.997%, Afrox”. The pure hydrogen gas was considered to ensure the non oxidation of the mercury nano-particles once formed within the BN host matrix. While the optimized decomposition period was shortened to less than 10 seconds, the final decomposed products were submitted to an instantaneous quenching process so to minimize the coalescence phenomenon of the formed mercury nano-particles within the BN host matrix.

**2. Transmission electron microscopy**

The transmission electron microscopy were conducted on a Zeiss 912-Omega transmission electron microscope is equipped with an in-line Omega filter for composition selective transmission imaging and quantitative electron diffraction. This moderate resolution (0.35nm) microscope has a liquid nitrogen-cooled double-tilt specimen holder, is capable of hollow-cone illumination for dark-field imaging, and is equipped with a slow-scan CCD camera for direct digital image acquisition. The **point resolution, voltage** and **magnification are:** TEM 0.34 nm, 60-120 kV and 80-500000x respectively.

**3. X rays diffraction**

The X-ray diffraction measurements were carried out on a standard Brucker type X rays diffraction unit with a lynx detector and a Ni-filtered CuK1 = 1.545Å” over the angular range of 2Q of 10-80 Deg. The total accumulation time was identical for all samples “≈7h30min”.

**Fig.AI.1:**Differential Scanning Calorimetry profiles of the 3 different samples; (a)Hg1/1-BN, (b) Hg1/4-BN, (c) Hg1/20-BN and (d) Hg1/20-BN.

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