

A new polythiophene-driven coating method on inorganic INT/IF-WS₂ nanomaterial surface

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The chemical stability of the organic layer present onto the WS₂ nanomaterial surface was examined in the following manner. The functional INT-WS₂ bithiophene linker nanomaterial was incubated for 1 hour (room temperature) within a 0.01M HCl (pH 4.0) acidic aqueous solution, in order to mimick acidic thiophene monomer oxidative liquid phase polymerization conditions. The corresponding TGA graphs (Figure SI-1) showed a quite minor difference in weight losses measured *before* and *after* such an aqueous acidic treatment.

Corresponding TGA graphs (Figure SI-1, non-oxidant N₂ flow)) of the **HCl-treated** composite vs. the **starting** functional polyCOOH one disclose a very little difference in weight losses for the indicated 350-650°C temperature range of measurements, *i.e.*, ~1.06% (7.08-6.02 = 1.06%). It clearly means that, during the 2nd step polythiophene polymerization/polymer growth from the INT surface, such an organic shell is significantly stable.

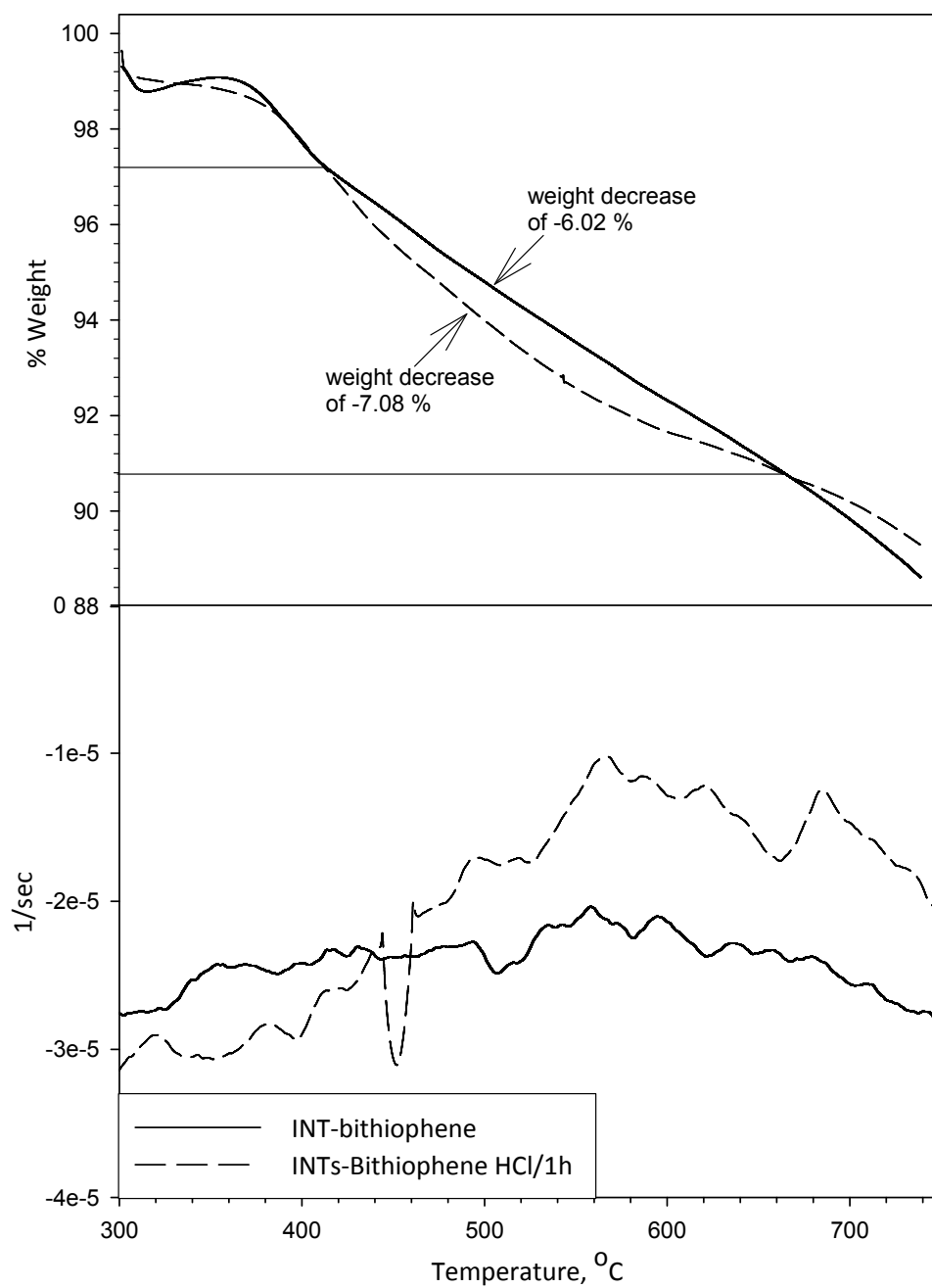


Figure SI-1: TGA analysis of INTs WS₂-bithiophene *before* and *after* acidic 0.01M aqueous HCl treatment (measured weight losses in a 350-650°C temperature range)

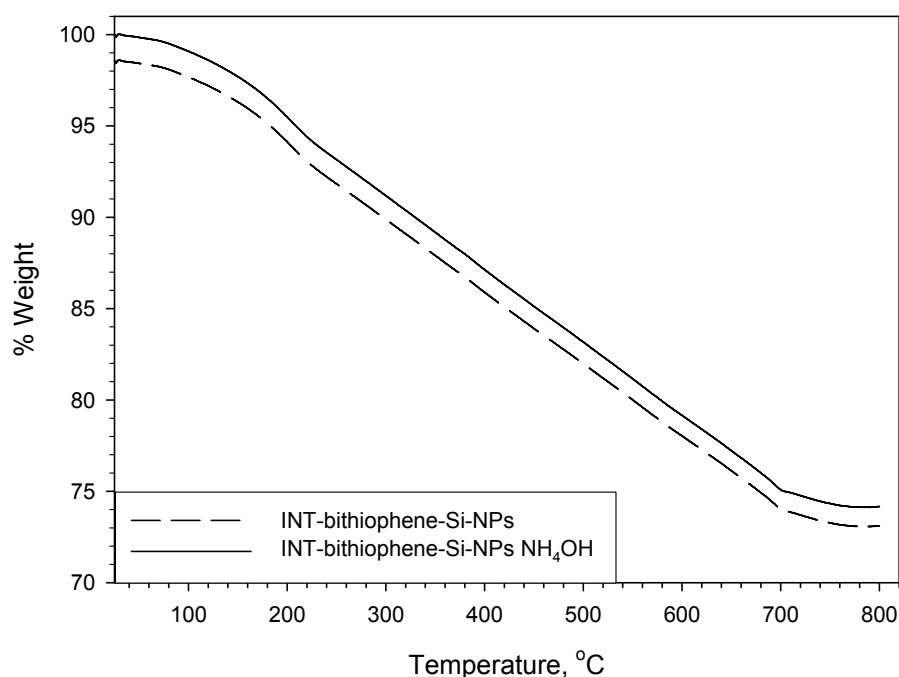


Figure SI-2: TGA analysis of INTs WS₂-bithiophene *before* & *after* basic aqueous 0.01M NH₄OH treatment (measured weight losses in a 20-800°C temperature range)

In addition and in order to more deeply address this functional layer thermodynamic stability issue for differently functionalized INT-bithiophene-Si-NPs, corresponding nanomaterials have been treated with a basic aqueous 0.01M NH₄OH (pH = 8.5) solution overnight (room temperature) mimicking the inorganic polymerization conditions described for INT nanotube functionalization. As shown in figure SI-2 above (TGA graphs), there is also less than 1.0% differential weight loss of functional coating. Thus, such basic conditions that fit 2nd step inorganic polymerization conditions did not cause any significant exfoliation of the attached organic adlayer.

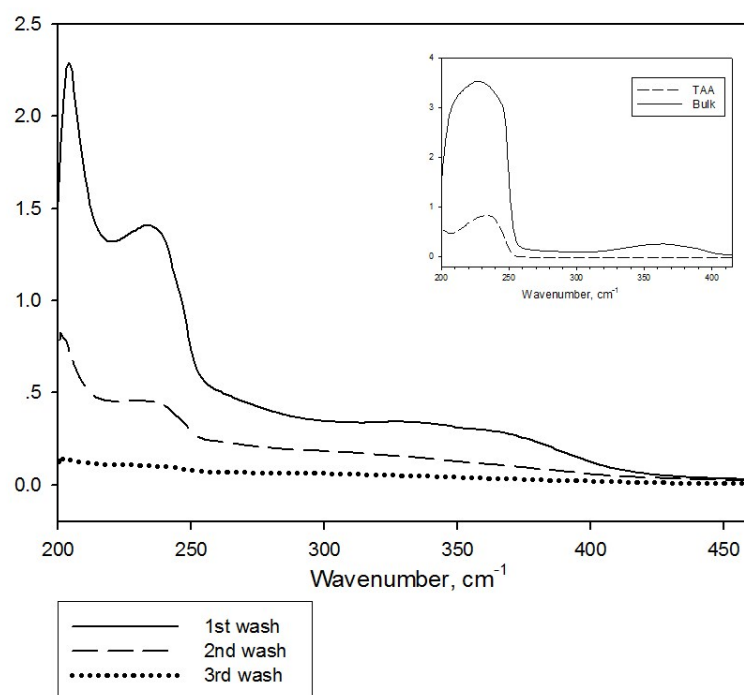


Figure SI-3: UV spectroscopy analysis of *washing media* arising from reacted INTs-WS₂-polymer nanomaterials

Polymer-decorated nanomaterials have been washed several times (x 3) using analytical grade EtOH. Thus, all the obtained composite washing solutions have been UV-tested (measurement scale: 200-800 nm, detection of conjugated Th and/or polyTh chromophore/species) to detect the presence of (i) thiophene acetic acid monomer and of (ii) any short polymerized polythiophene molecules/components. As clearly deduced from Figure SI-3 data, the 3rd wash step already disclosed **no UV-based evidence at all** for the presence of any further free UV-absorbing TAA or/or free polythiophene polymeric chains/species in the bulk solution (3rd wash UV graph).