Optical and Electrical Properties of Colloidal (spherical Au)-(Spinel Ferrite nanorod) heterostructures

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Supporting information

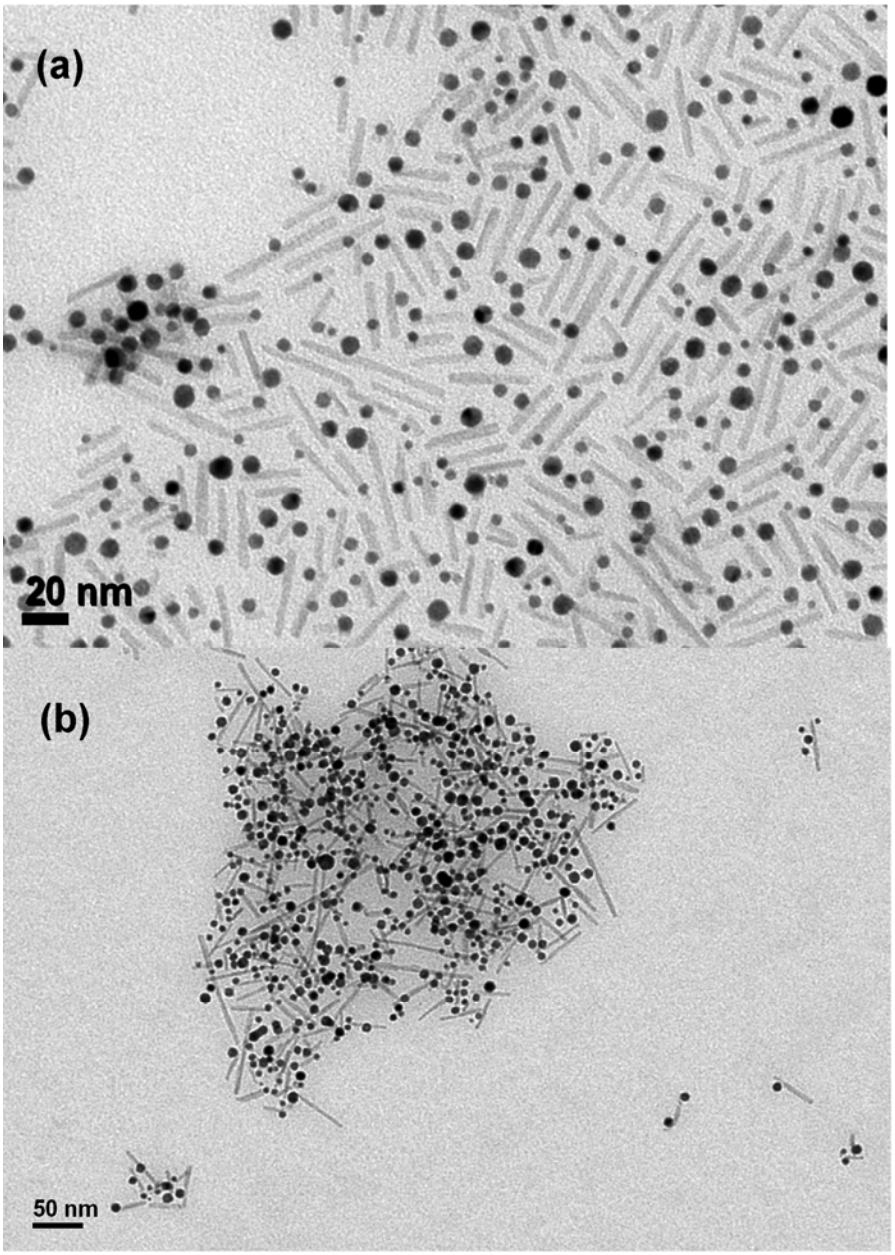

Figure S1. *TEM image showing the earliest stages of the growth of the Au-Fe_xO_y heterostructures (HSs). The Fe_xO_y section on each Au nanoparticle is already evident aliquots taken after (a) less than 5 seconds and (b) 2 min from the start of the reaction of $Fe(CO)_5$ on Au.*

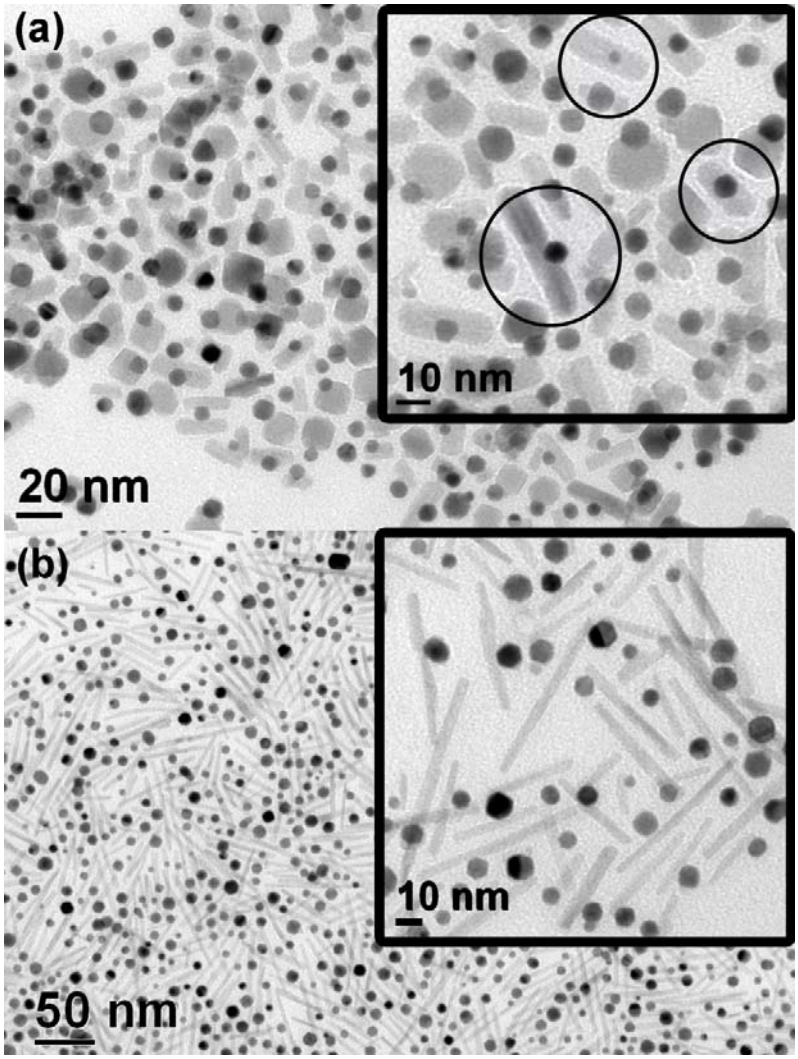

Figure S2. *TEM images showing Au-Fe_xO_y HSs synthesized using the following amounts of DDAB: (a) 1.5 mmoles and (b) 3 mmoles.*

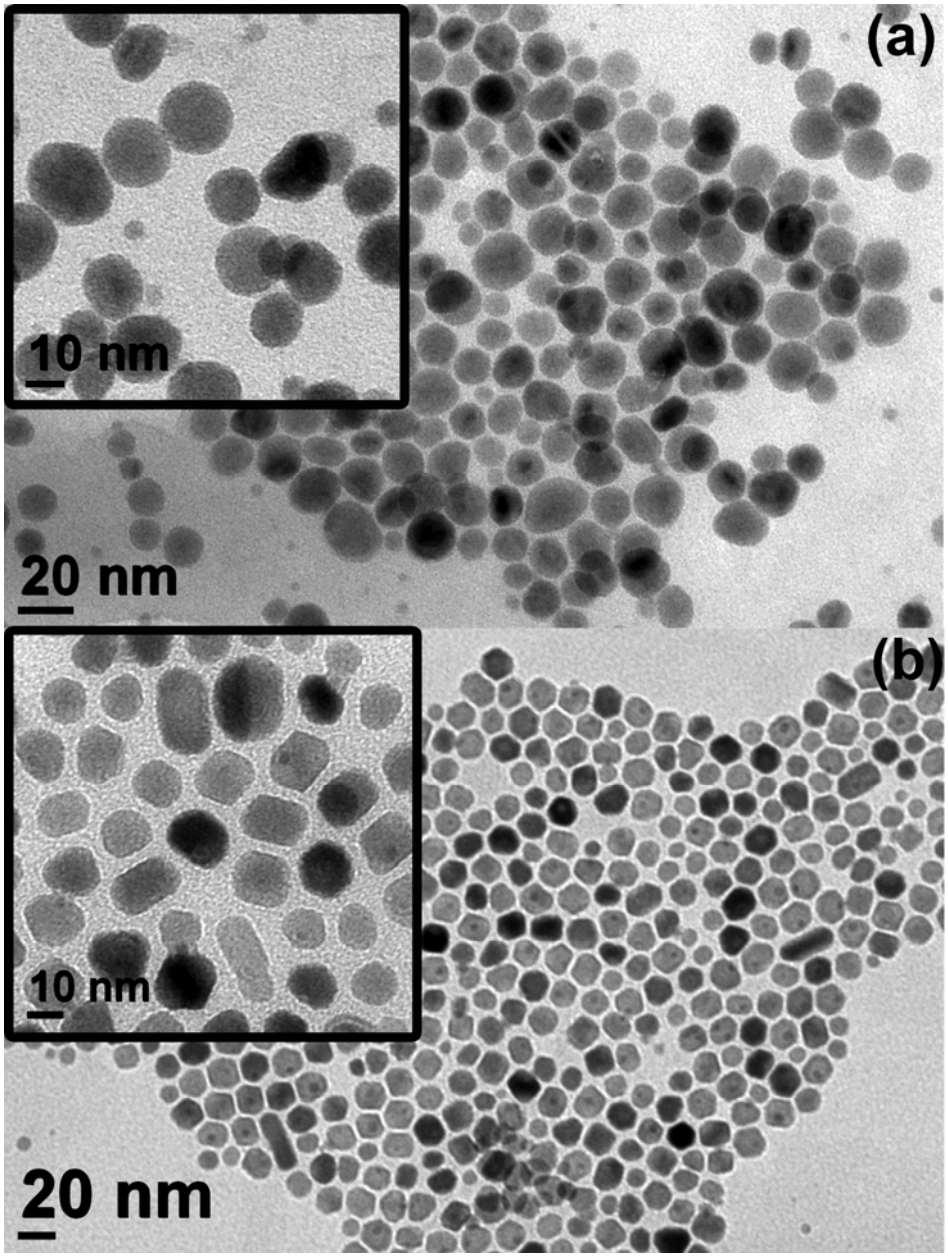

Figure S3. a) *TEM image of roughly spherical iron oxide (Fe_xO_y) nanocrystals synthesised without DDAB, but using only oleylamine and oleic acid as surfactants. The inset shows a magnified view of a few nanocrystals.* ***b)*** *TEM image of (Fe_xO_y) non-spherical oxide (Fe_xO_y) nanocrystals synthesized under the same conditions as for the sample shown in a) except for the additional presence of DDAB. Also, the conditions were the same as for the synthesis of the Au-Fe_xO_y HSs discussed in the main paper, except for the absence of the Au nanocrystals in the reaction environment. The inset shows a magnified view of a few nanocrystals.*

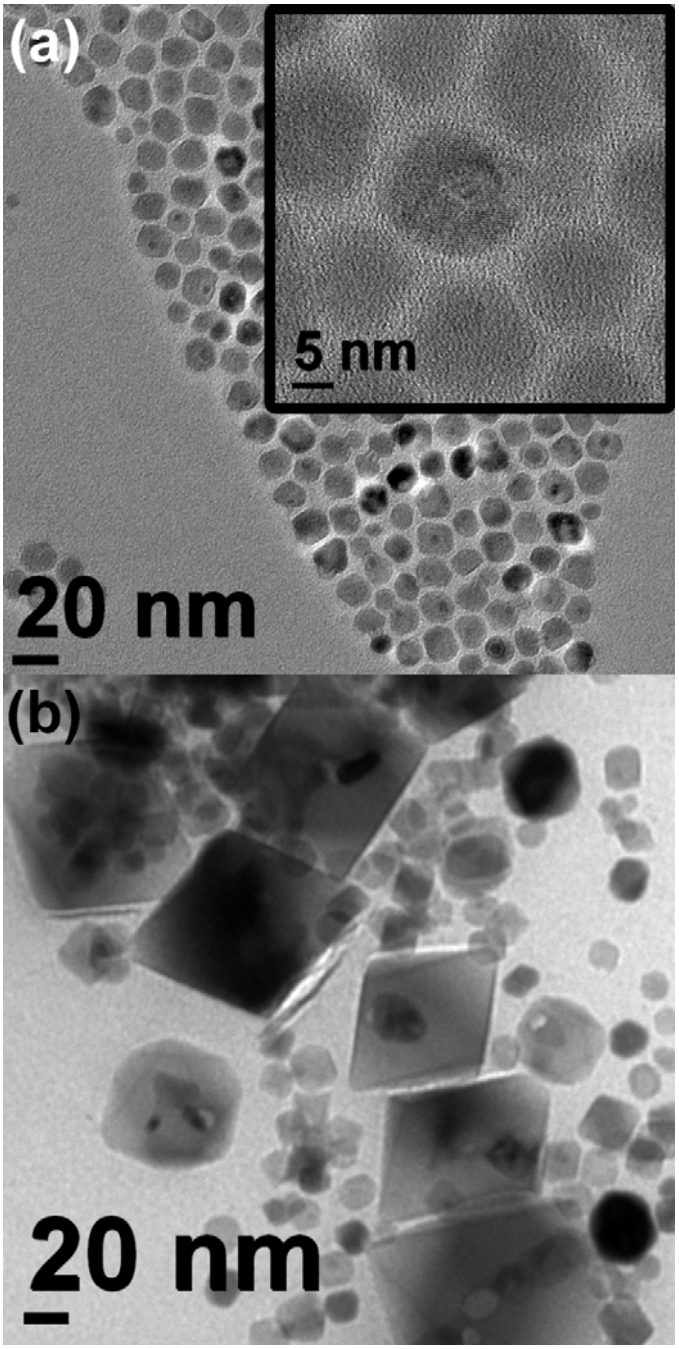

Figure S4. a) *Large area view and HRTEM (inset) of iron oxide (Fe_xO_y) nanocrystals synthesised in the presence of DDAB.* ***b)*** *TEM image of iron oxide (Fe_xO_y) nanocrystals synthesised in the presence of DDAB and using large amounts of iron pentacarbonyl. Two aspects are relevant here: i. The presence of DDAB induces strong faceting; ii) the particles exhibit a hollow region, most likely due to presence of an initial metallic Fe nucleus, which eventually was converted to iron oxide via the Kirkendall effect.*

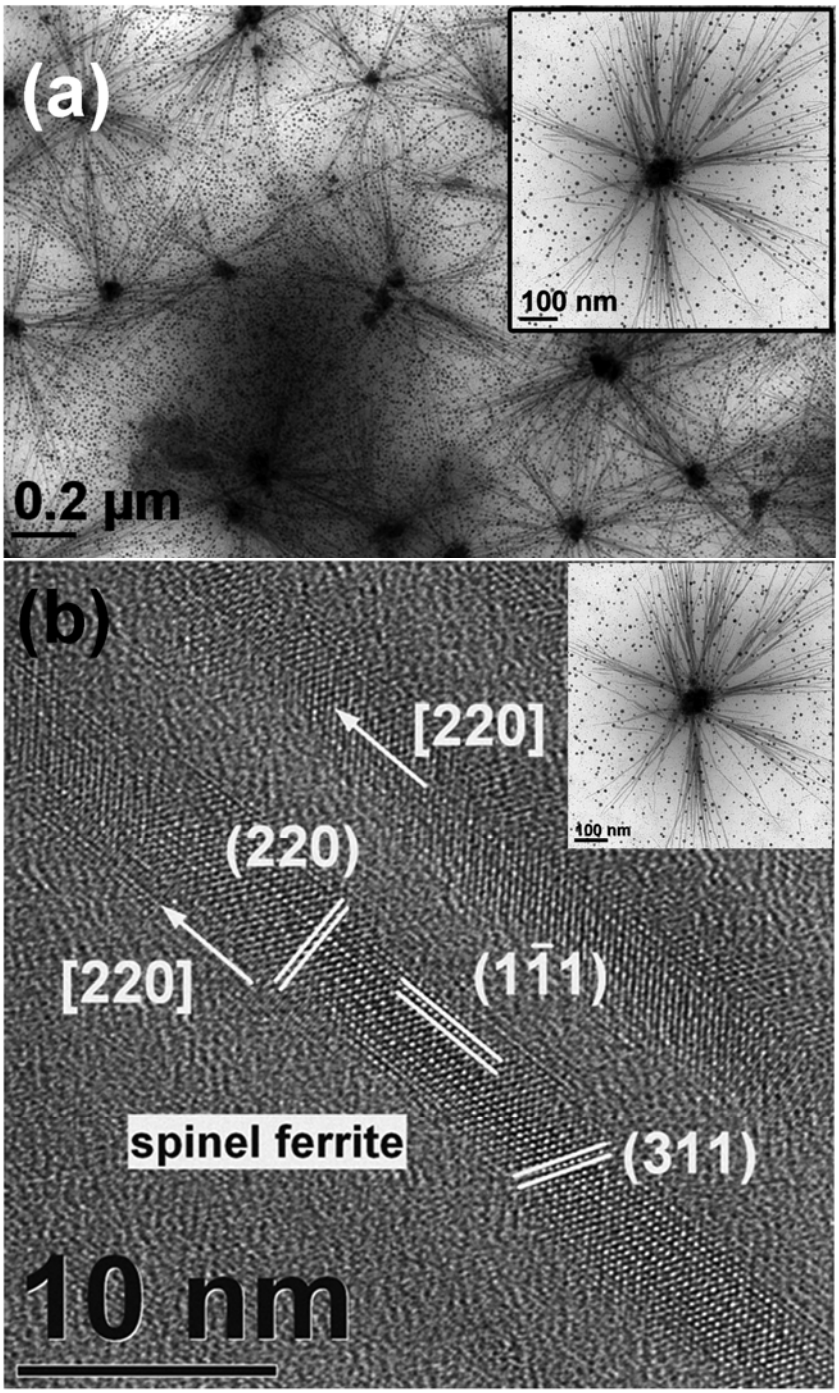

Figure S5. a) *TEM images showing the growth of iron oxide (Fe_xO_y) on gold seeds (Au) at higher concentration of DDAB, yielding urchin-like structures with branches of hundreds of nm in length and widths of 5-6 nm;* ***b)*** *HRTEM images of two almost parallel branches departing from an urchin structure (inset). Also in these branches the preferential growth direction is the [2 2 0] one.*

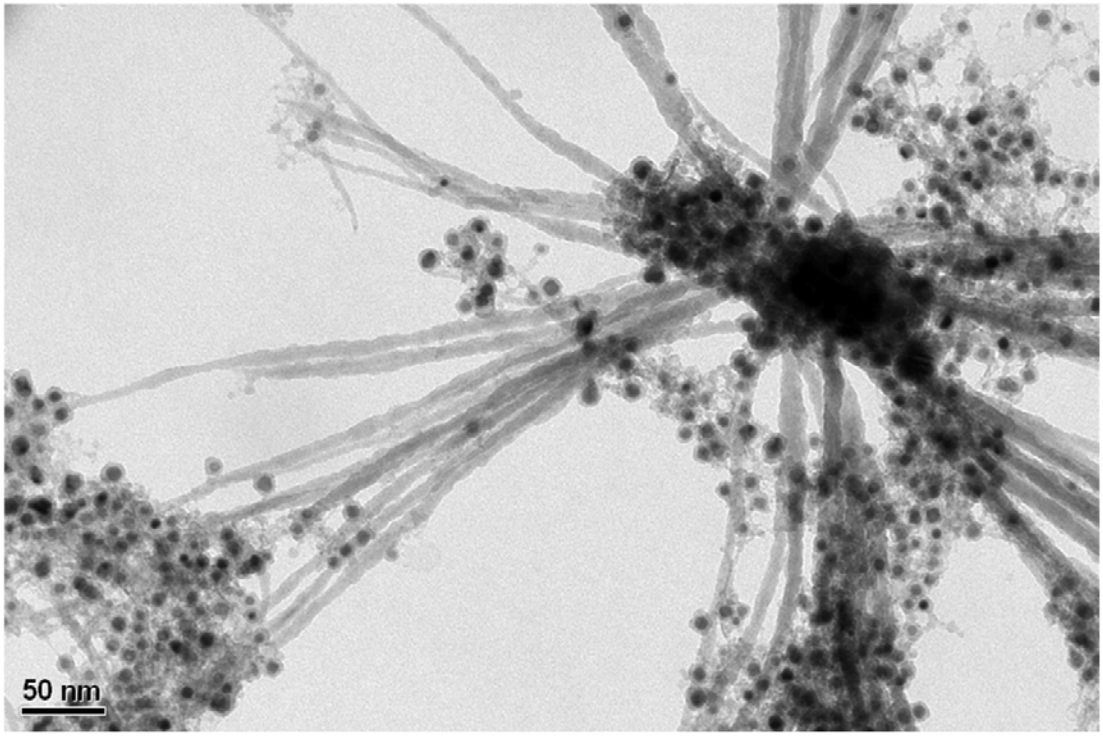

Figure S6. *TEM images showing the urchin like Au-(Fe_xO_y) structures after exposure to iodine (I_2). In this case not all the Au nanoparticles could be leached out, because most of them were covered by a thick iron oxide shell.*

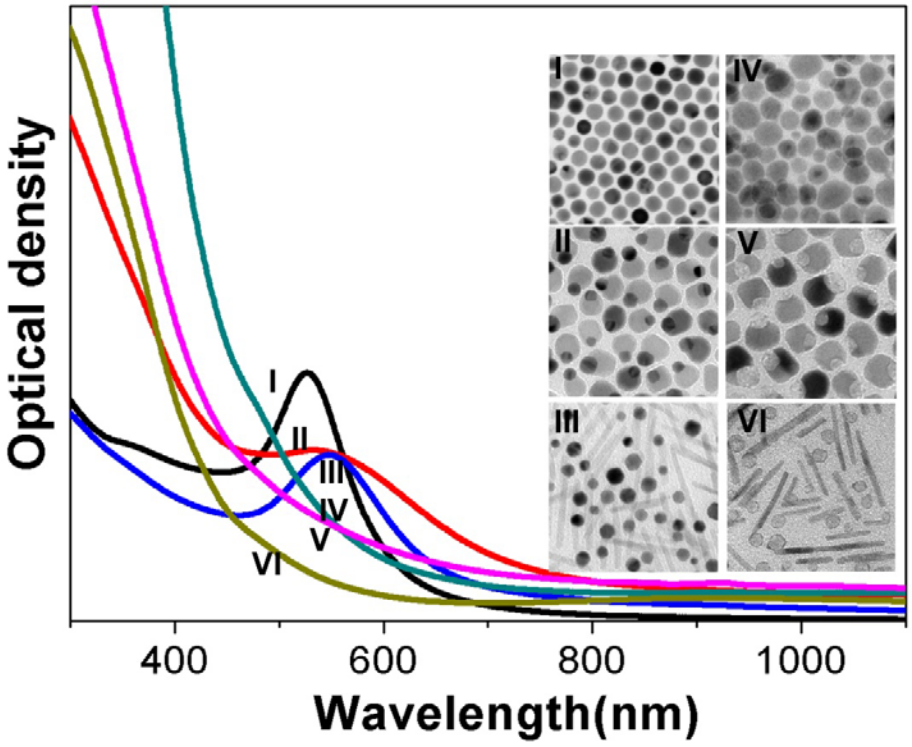

Figure S7. *UV-VIS-NIR optical absorption spectra of: I) spherical gold nanocrystal seeds; II) Au-Fe_xO_y dumbbells; III) Au-Fe_xO_y HSs; IV) Fe_xO_y nanocrystals; V) nanocrystals obtained after leaching Au from the Au-Fe_xO_y dumbbells; VI) Fe_xO_y HSs obtained after leaching Au from the Au-Fe_xO_y HSs.*

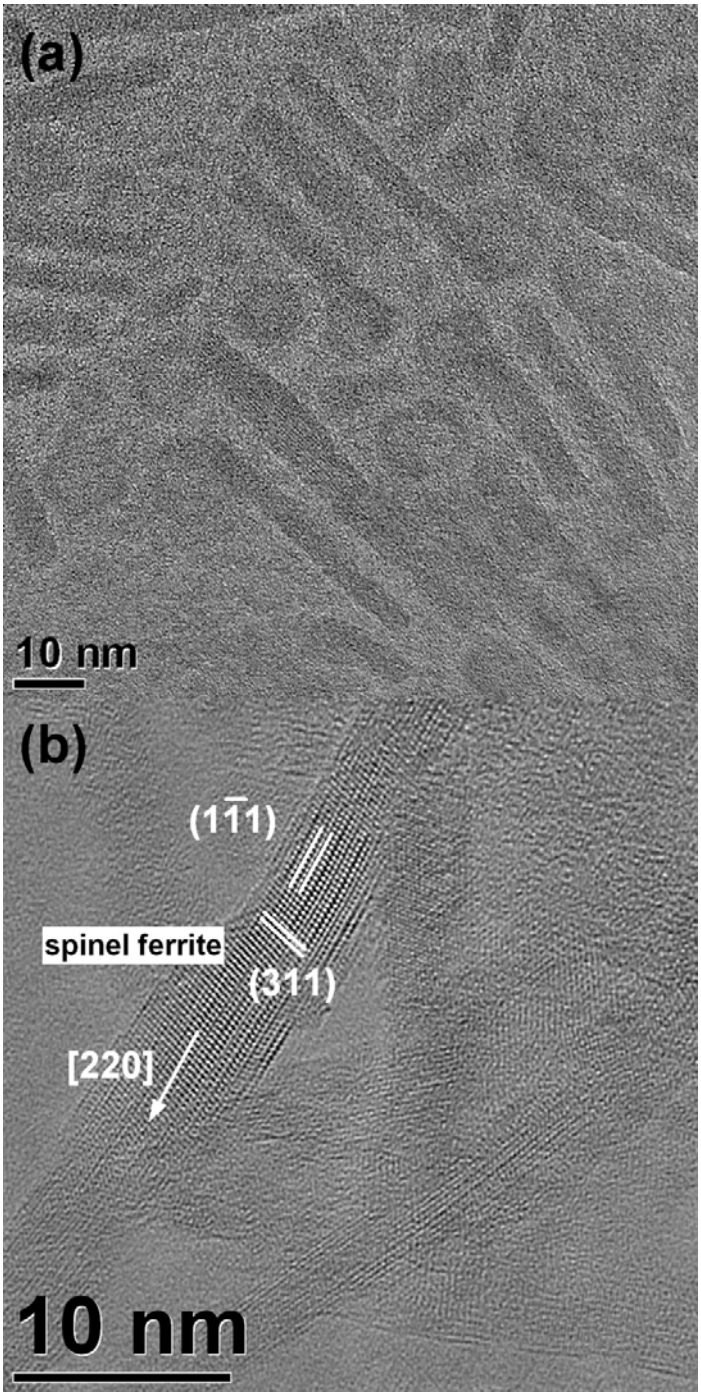

Figure S8. (a-b) *HRTEM images of the Fe_xO_y HSs obtained after leaching Au from the Au-Fe_xO_y HSs.*

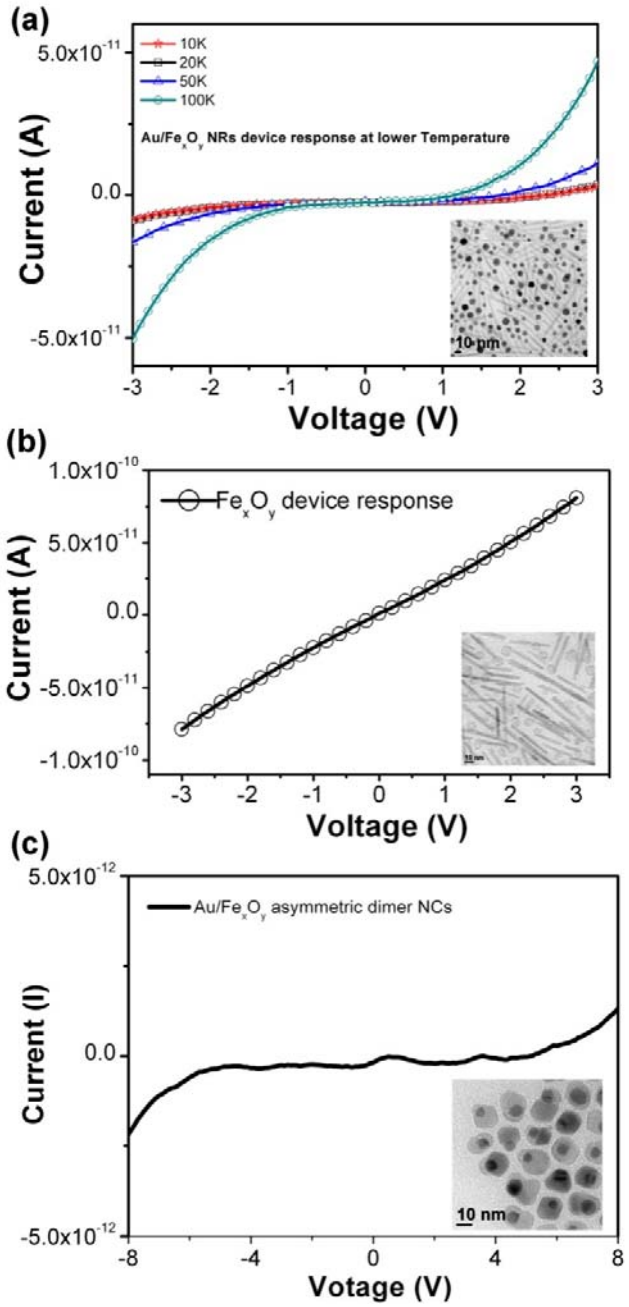

Figure S9. *I-V characteristics of films made of:* ***a)*** *Au-Fe_xO_y HSs at various temperatures;* ***b)*** *Fe_xO_y HSs obtained after leaching Au from the Au-Fe_xO_y HSs;* ***c)*** *Au-Fe_xO_y dumbbells.*

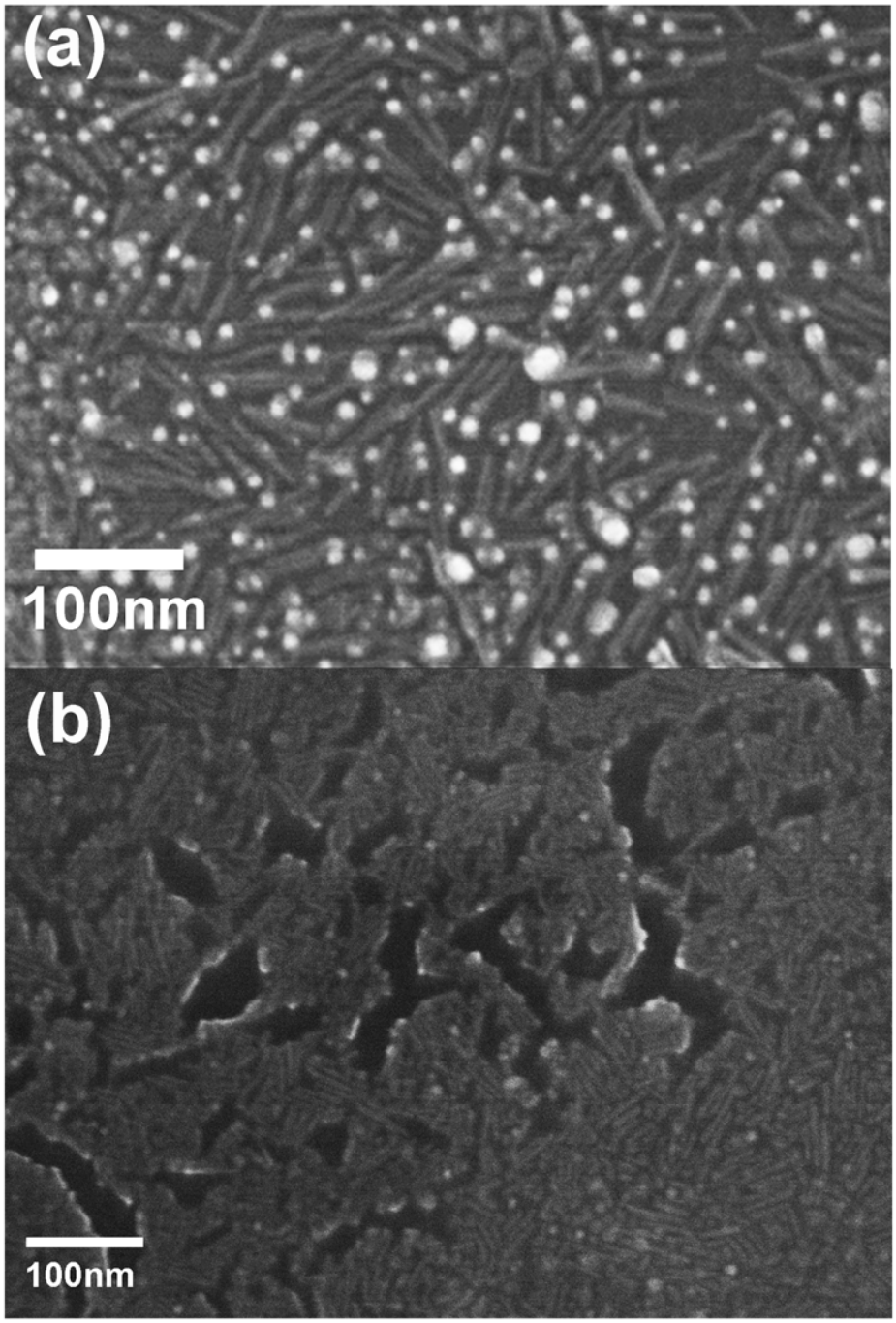

Figure S10. *Scanning electron microscopy (SEM) images of: a) Au-Fe_xO_y HSs drop-cast onto a silicon substrate; b) Fe_xO_y HSs obtained after leaching Au from the Au-Fe_xO_y HSs, also drop-cast onto a silicon substrate.*

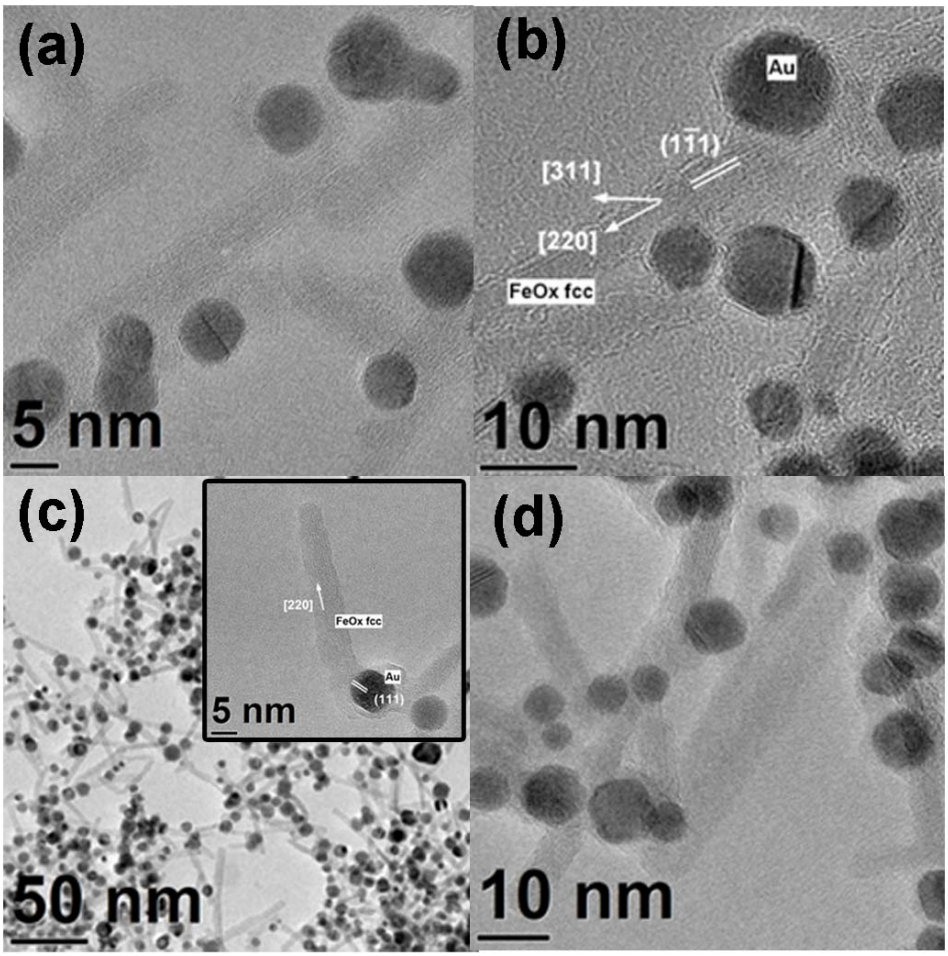

Figure S11. *a) TEM image of as-prepared Au-Fe_xO_y HSs sample; b) Au-Fe_xO_y HSs sample annealed at 200℃ for 15 min; c) Au-Fe_xO_y HSs treated with hydrazine, retaining the original Au-Fe_xO_y interfacial relationship after hydrazine treatment. d) Au-Fe_xO_y HSs treated with hydrazine and annealed at 200℃ for 15 mins, showing that the samples remained stable.*

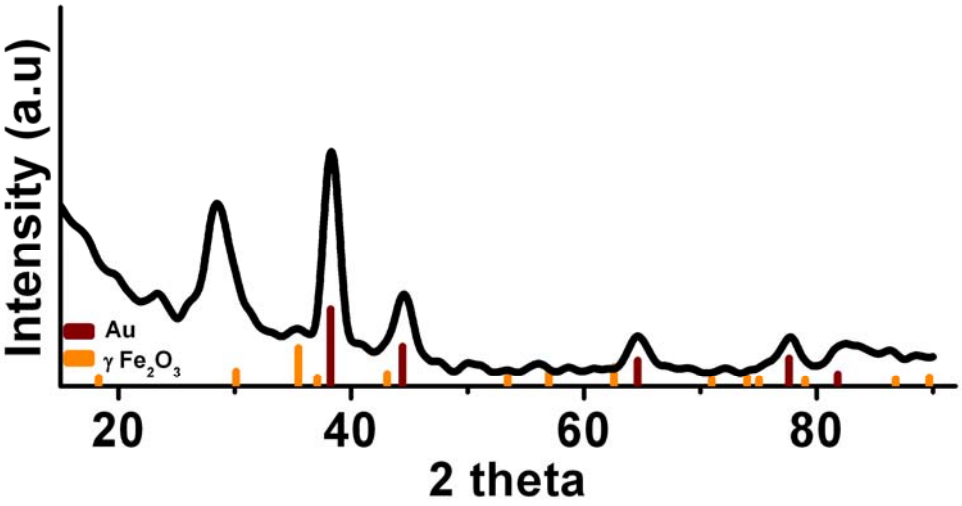

Figure S12. *X-ray diffraction (XRD) pattern of a typical sample of Au- Fe_xO_y HSs.*