

### Supporting information

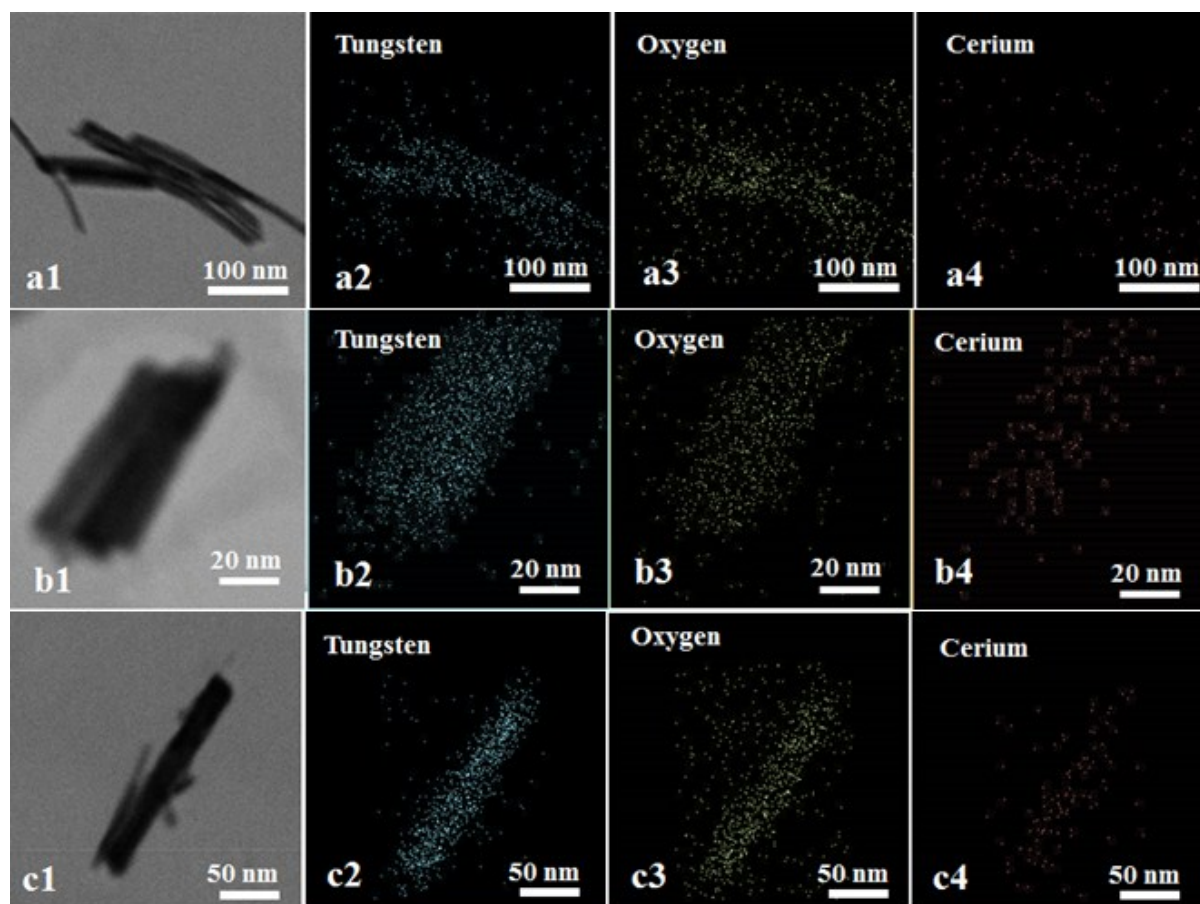


Figure S1 Element mapping images of the Ce/W = 1:15 sample (a1-4), 1:10 sample (b1-4) and 1:5 sample (c1-4). The blue, yellow and red dots represent the distribution of W, O and Ce.

The element mapping has confirmed that the homogeneous distribution of the constituent elements W and O are clearly dominant in the nanowires (Figure S1). Ce is also visible and presented across the entire nanowire and is most likely existing inside the parental  $WO_x$ . The atomic percentage of the 1:5 sample consists of 60.3, 34.1 and 5.6 at% of O, W and Ce respectively, the 1:10 sample has 74.8, 22.2 and 3 at%, and the 1:15 sample has 69, 29.1 and 1.95 at% for O, W and Ce respectively.

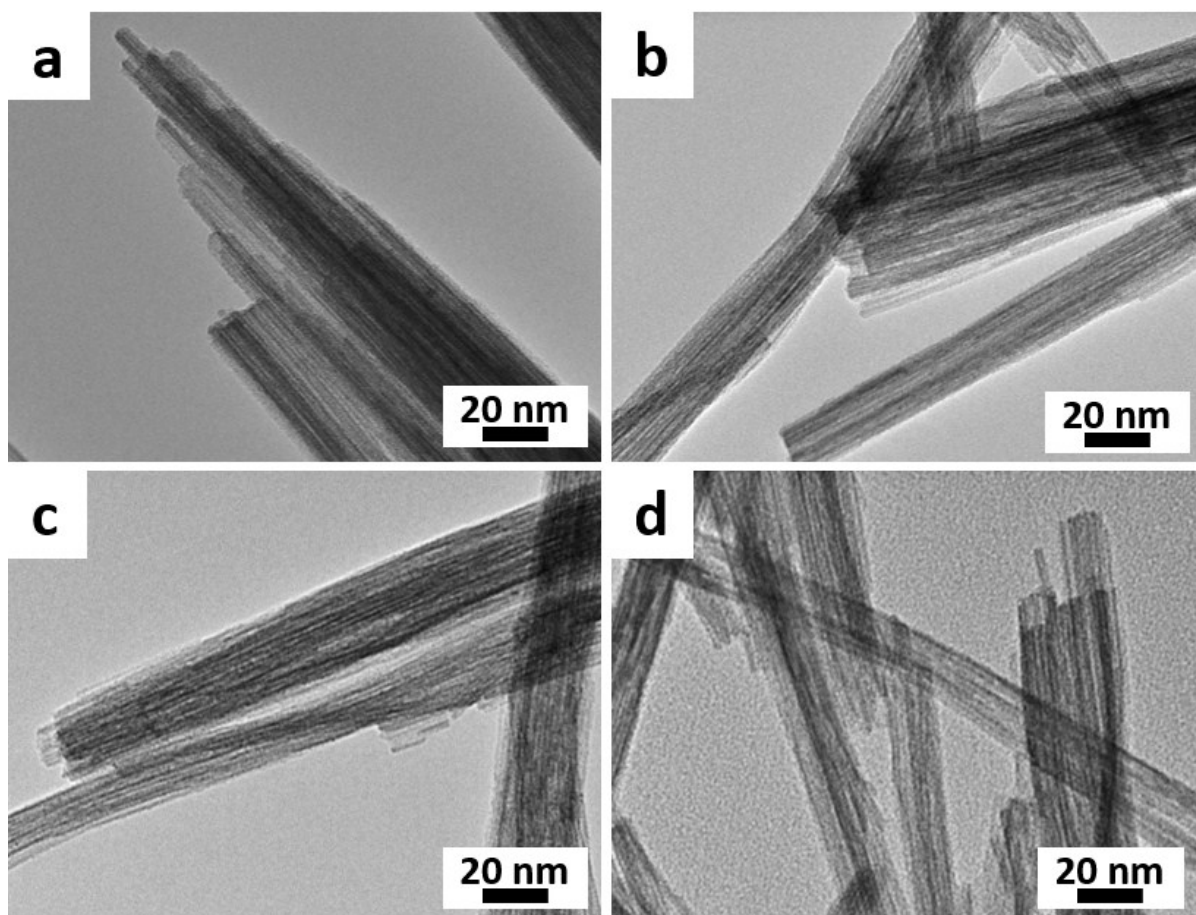


Figure S2 HRTEM images. (a) The plain  $W_{18}O_{49}$ , (b)  $Ce/W = 1:15$  sample, (c)  $Ce/W = 1:10$  sample and  $Ce/W = 1:5$  sample.

The bundled nanowires for all samples (doped and un-doped) have been confirmed by the HRTEM images. Moreover, they also confirm that the bundle size of the doped samples are decreased upon doping. The agglomerations for the  $Ce/W=1:10$  and  $1:5$  samples are not shown, as images cannot be taken due to their huge size.

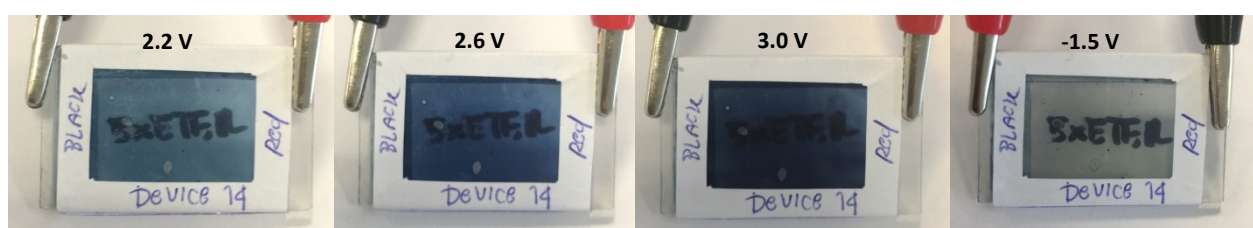


Figure S3 Representative coloration evolution of the device at various voltages applied.