

## Supporting information

### Probing the stoichiometry dependent catalytic activity of nickel selenide counter electrodes in the redox reaction of iodide/triiodide electrolyte in dye sensitized solar cells

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## 1.0. J-V characteristic of Pt reference device at 100 mW/cm<sup>2</sup> light intensity

The devices were fabricated and tested in air which leads to non-ohmic contacts of different magnitude resulting into an extraction barrier. This led to a mobility mismatch of charge carriers resulting into significant increase of surface recombination velocity [1] that usually leads to S-shaped current-voltage curves. This is strongly dependent on light intensity. At low light intensity (below 70 mWcm<sup>-2</sup>), the electric field is assumed homogeneous over the active layer, resulting in a linear gradient of the energy bands [2]. The situation changes drastically as the light intensity is increased beyond 70 mWcm<sup>-2</sup> where we observed severely changed current density-voltage graph that is highly S-shaped as shown in Fig. S1

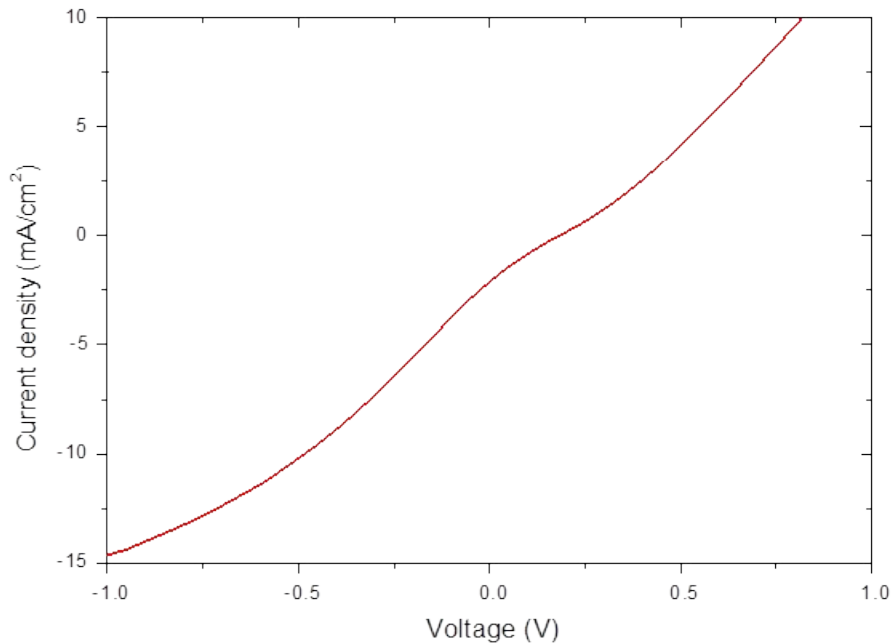


Figure S1: Current density-Voltage graph of reference device at 100 mW/cm<sup>2</sup> light intensity.

## 2.0. Stability test for the as-synthesized Ni<sub>x</sub>Se<sub>y</sub> counter electrodes

The long-term stability of DSSCs is one of the most important photovoltaic parameters and can be reflected by the consecutive CV scans. To demonstrate the stability of Ni<sub>x</sub>Se<sub>y</sub> in the iodine electrolyte and their reliability as counter electrodes, several scans of CV measurements were done and the results depicted in Fig. S2. Again here, the Pt was used as control. The results confirmed that the as-prepared counter electrodes exhibited an excellent chemical stability in the electrolyte solution with little degradation in current densities or peak shifts after 30 scans at 50 mV/s.

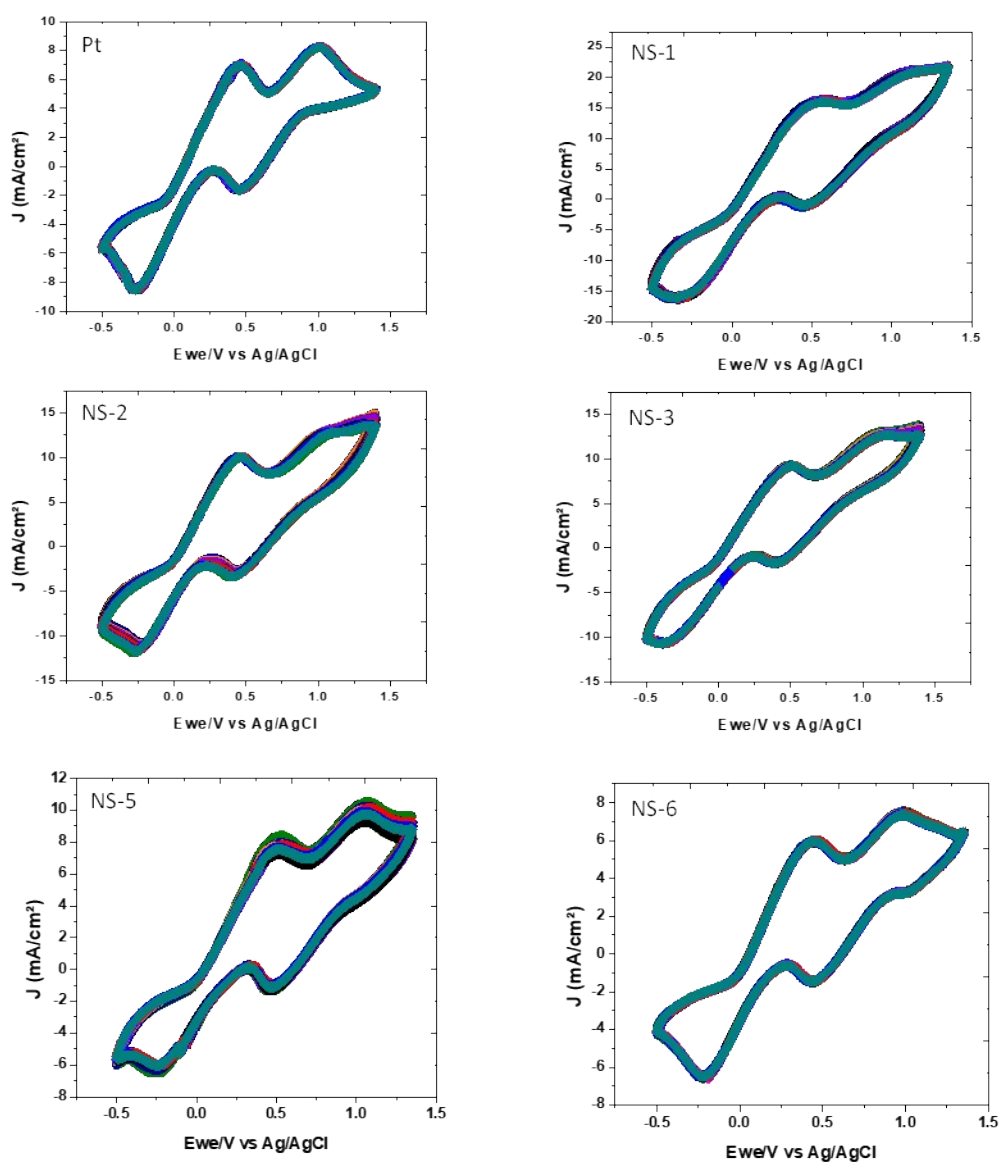


Figure S2: 30 consecutive CV scans for the as-synthesized CE with the scan rate of 50 mV s<sup>-1</sup>.

## References

- [1] D. Scheunemann, S. Wilken, O.J. Sandberg, R. Österbacka, M. Schiek, Effect of imbalanced charge transport on the interplay of surface and bulk recombination in organic solar cells, *Physical Review Applied*, 11 (2019) 054090.
- [2] S. Wilken, O.J. Sandberg, D. Scheunemann, R. Österbacka, Watching Space Charge Build Up in an Organic Solar Cell, *Solar RRL*, 4 (2020) 1900505.