SUPPORTING INFORMATION

**WSe₂ nanoparticles with enhanced hydrogen evolution reaction prepared by bipolar-electrochemistry: application in competitive magneto-immunoassay**

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**Figure S1.** Detail from HR-TEM image with atomic fringes and corresponding spacing (0.27 nm). The scale bar is 3 nm.
Figure S2. Pictures obtained by AFM and corresponding height profiles of A) WSe$_2$ t-buli, B) WSe$_2$ BE and C) WSe$_2$ NPs with scale bars 10, 10 µm and 500 nm, respectively. C) A five-layers nanoparticle is shown in left-handed image, while single-layer particle is in the right-handed image. Moreover, shown profiles were taken from more nanoparticles.

Figure S3. XRD patterns of WSe$_2$ samples in which the most intense reflections were labelled.
Figure S4. Electrochemical stability tests: A) HER polarisation curves of WSe₂ before and after 100 and 200 cyclic voltammetry cycles in sulfuric acid (0.5 M), and B) HER onsetpotentials at -10 mA cm⁻² from WSe₂ NPs after 3 days, 3 moths and 12 moths. The error bars are based on three measurements.

Figure S5. Electrochemical stability of WSe₂ NPs conducted by chronoamperometry using -1.2 V.

Figure S6. HR-XPS spectra obtained after the chronoamperometric test of stability. Bar chart is a comparison of the content of WSe₂ and WO₃ in WSe₂ NPS before and after the test of stability. The erro bars are based on two measurements.
Figure S7. A) The TEM image of WSe\textsubscript{2} NPs after the chronoamperometric test of stability. B) Detail from HR-TEM image with atomic fringes with corresponding spacing (0.27 nm). The scale bar is A) 70 nm and B) 5 nm.

Figure S8. A) As measured LSV of HER conducted in acidic, neutral and alkaline electrolytes. B) The potential was recalculated vs normal hydrogen electrode.
**Figure S9.** Chronoamperograms of WSe$_2$ NPs on SP electrode measured with three different applied potentials.

**Figure S10.** A) Chronoamperometry responses of protein detection in competitive magneto immunoassay configuration under different concentration of rabbit IgG labelled with WSe$_2$ NPs (legend) with 500 ng/ml of label-free IgG. B) Current response after 200 s with error bars based on three measurements.