

1. Supplementary information

1.1 Synthesis of silanized and heterobifunctional PEGs

Methoxy polyethylene glycol 5000 g.mol⁻¹ (mPEG₅₀₀₀) was silanized with 3-isocyanatopropyltriethoxysilane (IPTES) with a molar excess of 1.8 IPTES for 1 PEG in THF at 20°C, 700 rpm for 5 days under inert atmosphere^{55,56}. After reaction THF was evaporated and the mPEG₅₀₀₀-Si was precipitated in heptane, filtered and freeze dried before use.

Heterobifunctional PEG was prepared to be grafted on nanoribbons *via* silane groups and to provide, at the other end, reactive groups for protein interactions. To this end, the carboxymethyl ester of N-hydroxysuccinimide (NHS) chemical group was chosen to increase reactivity between NHS and proteins.

Commercial NHS-PEG₅₀₀₀-OH (JenKem Technology) was silanized with (IPTES) following and updating a protocol found in literature⁵⁷. Briefly, IPTES and NHS-PEG₅₀₀₀-OH were mixed at a 5:1 molar ratio in CH₂Cl₂ at 40°C, 700 rpm for 5 days under inert atmosphere (Figure SI_1). The NHS-PEG₅₀₀₀-Si obtained with a yield of 80% was also freeze-dried before use and characterization.

Figure SI_1. Reaction to obtain bifunctional PEG₅₀₀₀ with NHS ester and triethoxysilane groups (NHS-PEG₅₀₀₀-OH: NHS ester functionalized PEG₅₀₀₀).

1.2 Study of the reproducibility of the synthesis of TiONRs by TEM and X-Ray Diffraction of TiONRs

The structure of the nanoparticles was obtained using different characterization techniques. To measure chemical structures of TiONRs, X-ray diffraction (XRD) was realized on an INEL CPS 120 diffractometer with Cu K α radiation ($\lambda = 1.54056 \text{ \AA}$). Determination of the peak positions as well as curve fittings were performed on Fityk.59 software

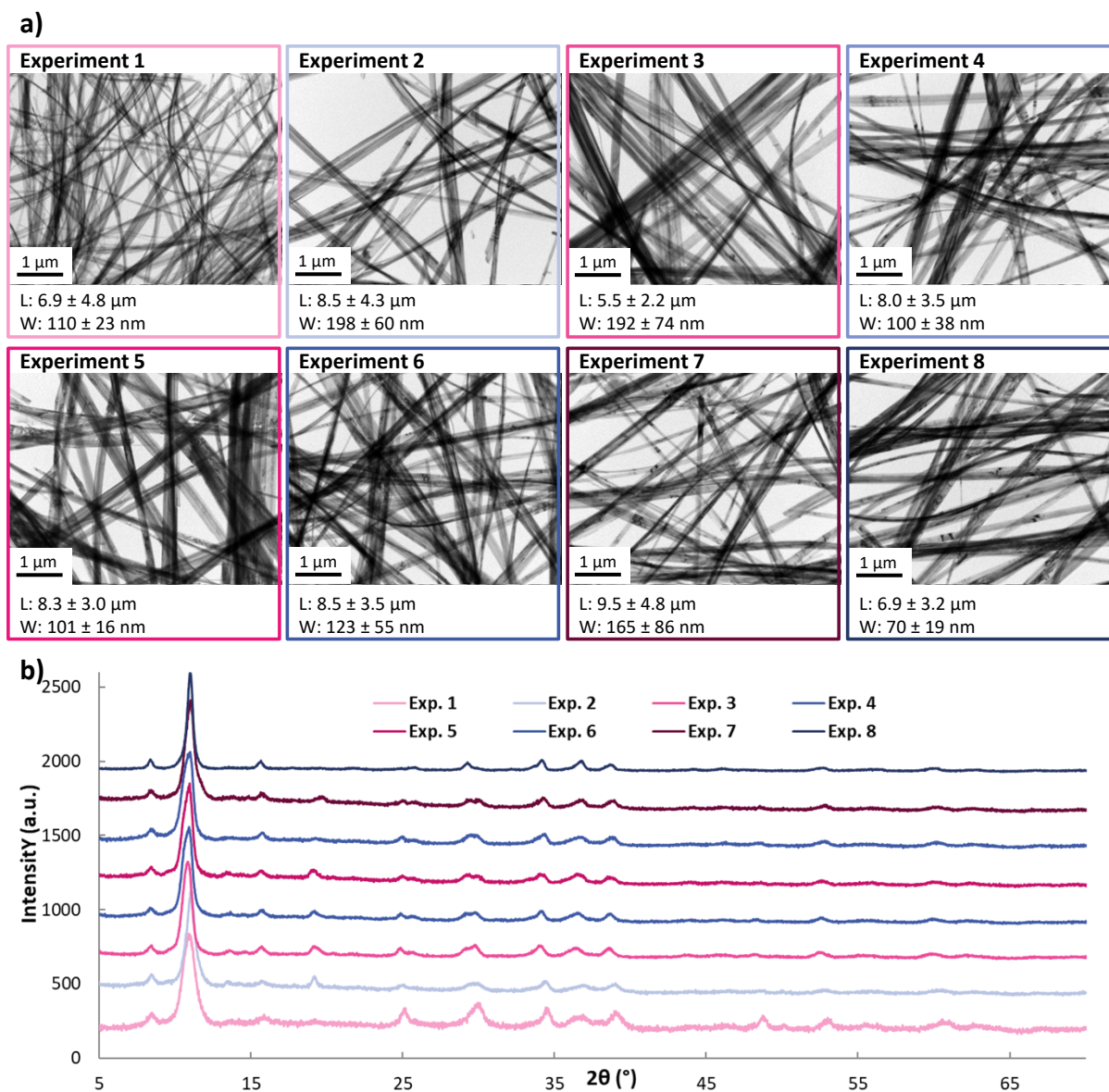


Figure SI_2 : a) TEM pictures of eight independent syntheses of TiONRs with characteristics showing the morphological reproducibility of the TiONRs (L: length, W: width measured on different TEM images at different magnifications) ; b) X-Ray Diffraction patterns of the same eight syntheses showing the chemical reproducibility of TiONRs

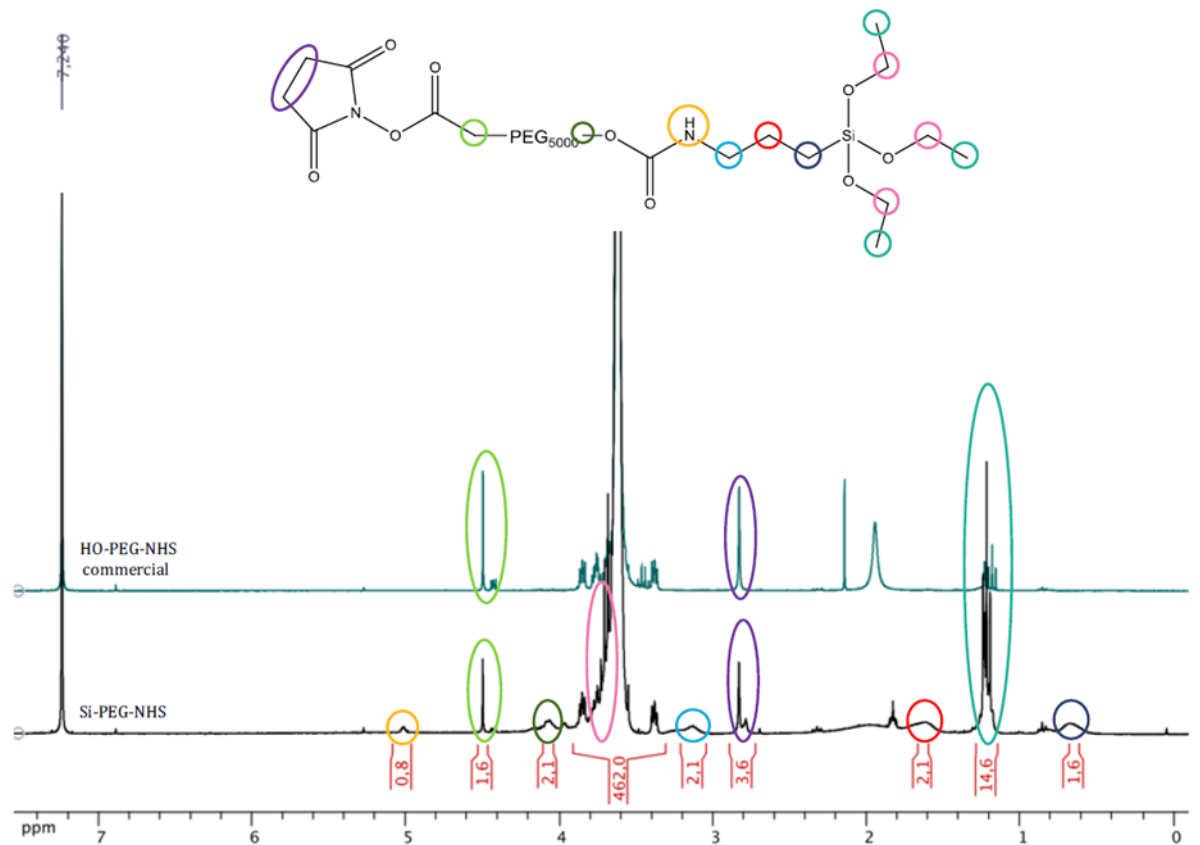


Figure SI_3 ^1H NMR Spectra of the bi-functional NHS-PEG₅₀₀₀-Si (bottom) and starting NHS-PEG₅₀₀₀-OH (top) (300 MHz, CDCl₃, 293K)

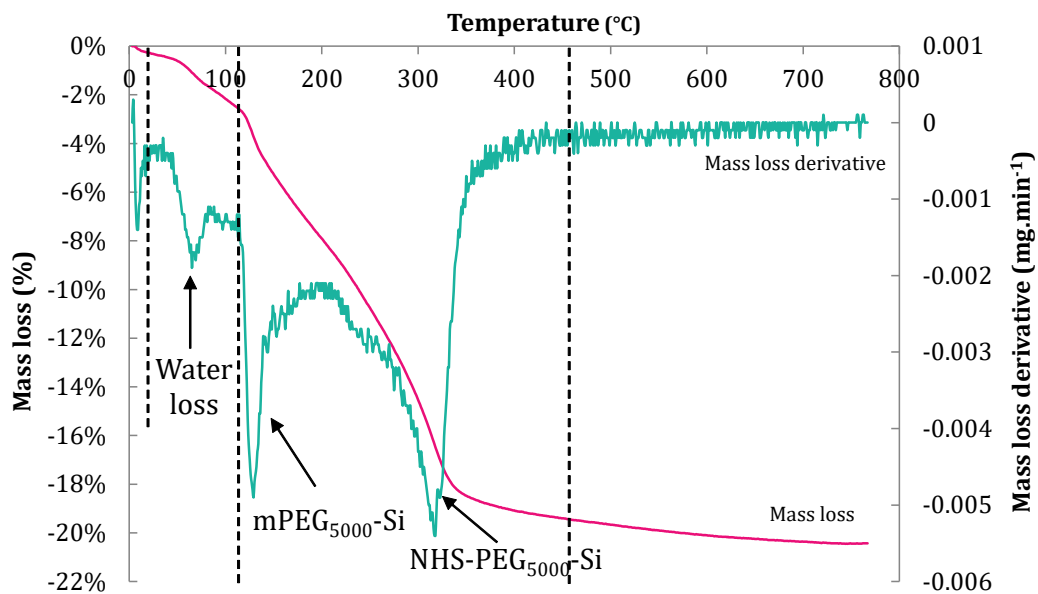


Figure SI_4. Thermogravimetric Analyses of PEG-functionalized Titanate nanoribbons

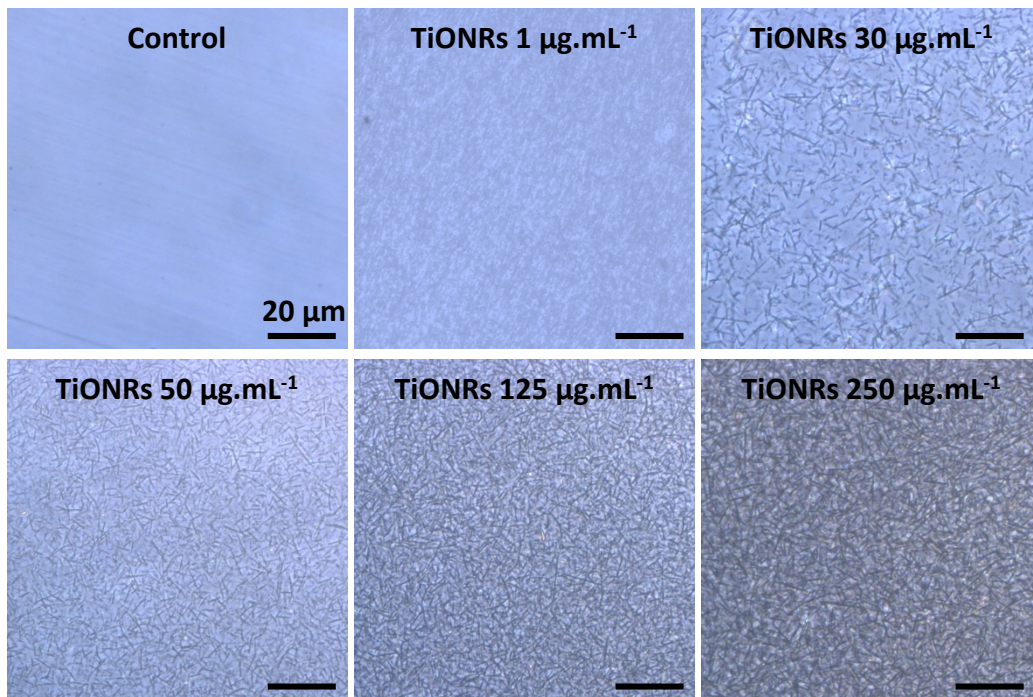


Figure SI_5. Optical microscopy images of cell culture plates covered with different concentrations of TiONRs. Below 50 µg.mL⁻¹ the plate is not fully covered and above this value, there are multilayers of TiONRs. Scale bars: 20 µm