SURFACE MODIFIED PLATINUM NANOCRYSTAL-BASED SILICON NANOTUBES FOR ENHANCED CANCER CELL TARGETING

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I. Introduction

Alternatively, small Pt nanocrystals (Pt NCs) have demonstrated arrested growth and apoptosis in cancer cells as a consequence of DNA platination and enhanced strand-breaks initiated by leaching Pt(II) ions from the NC surface in the acidic intracellular environment. Such nanocrystals tend to aggregate extensively in an aqueous environment, however, and we have developed well-defined Silicon nanotubes (pSiNTs) as a scaffold for effective nanocarrier for drug delivery of such PtNCs, taking advantage of nanotube high surface area, biocompatibility, and biodegradability. To enhance the specificity of this material we conjugate Folic Acid (FA) to the Pt surface, with the goal of enhanced targeting of overexpressed FARs and more selective cancer cell uptake.

II. Methods

A. Synthesis of Silicon Nanotubes (SiNTs)

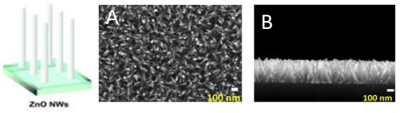

Fig 1. (A) SEM image of ZnO NWs on fluorine-doped tin oxide (FTO) substrate; (B) SEM image cross-section of ZnO NWs on FTO substrate. Growth of ZnO NWs at 95◦C.

Deposition of Si on ZnO Nws via chemical vapor deposition of SiH_4 at 543 ◦C.

Fig 2. Si/ZnO NWs

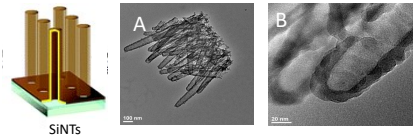

Fig 3 (A) TEM image Silicon Nanotubes (SiNTs) low magnification; (B) Higher magnification

B. Formation of Pt Nanocrystals on SiNTs

1. Functionalization of SiNTs with primary amino groups using APTES

Zeta Potential analysis was performed to evaluate the surface charge of SiNTs before and after APTES functionalization.

Fig 4. Scheme of functionalization of SiNTs with 2% of APTES in Toluene for 4 h at room temperature

Table 1. Zeta Potential of SiNTs before and after functionalization in DI water at pH 6.5

Samples	Zeta Potential (mV)
Unmodified SiNTs	-17.04 ± 0.70
APTES-functionalized SiNTs	+35.87 ± 1.96

2. Incubation of APTES-SiNTs in K_2PtCl_4 solution at room temperature.

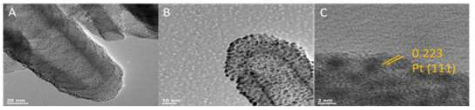

Figure 5: Formation of the PtNCs on SiNTs after being incubate with Pt salt precursor 1.5 mM 24 h A. PtNCs on SiNTs scale bar 20 nm. B. PtNCs on SiNTs scale bar 10 nm. C. Lattice spacing of PtNCs on SiNTs scale bar 2 nm

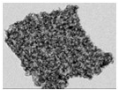

Table 2. Elemental analysis of Bundle PtNCs-SiNTs (TEM-EDX)

Element	Wt%
Oxygen (O)	10.64
Silicon (Si)	36.80
Platinum (Pt)	51.64
Chlorine (Cl)	0.93

3. Conjugation of PtNCs-SiNTs with Folate

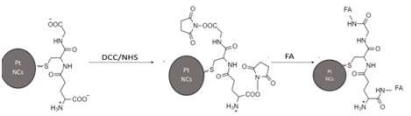

Fig 6. Scheme of Folic Acid attachment with PtNCs, using Glutathione as a linker

III. Results

A. FT-IR spectra Folate-PtNCs-SiNTs

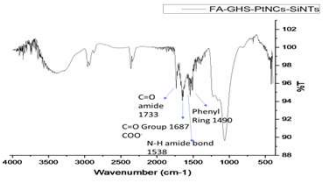

Fig 7. FT-IR spectra of FA-PtNCs-SiNTs

B. Characterization by X-ray Photoelectron spectrum (XPS)

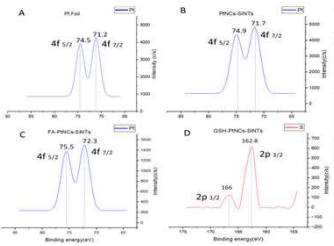

Table 3: Pt XPS values for different oxidation states

Pt	Pt 4f-7/2 (eV)	Pt 4f-5/2 (eV)
Pt (0)	71.2	74.4
Pt(+2)	72.9	76.2
Pt(+4)	75.6	79.0

Material	Pt 4f-7/2 (eV)	Pt 4f-5/2 (eV)
Pt Foil	71.2	74.5
PtNCs-SiNTs	71.7	74.9
FA-PtNCs-SiNTs	72.3	75.5

Figure 8: The XPS of FA-GSH-PtNCs-SiNTs. A: elemental Pt (foil), B: Pt of PtNCs-SiNTs, C: Pt of FA-PtNCs-SiNTs, D: S of GSH-PtNCs-SiNTs (this was made with the assistant of Dr. Roberto Gonzalez-Rodriguez)

C. Cell Viability Experiments

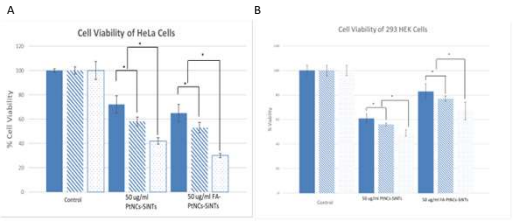

Figure 9: Cell viability after treatment with PtNCs-SiNTs and FA-PtNCs-SiNTs against **A**.HeLa cells and **B**. 293 HEK Cells.

IV. Conclusions and Future Work

- Conjugated Folic Acid to the material can Kill more HeLa cells via Folate receptors (FRs).
- Conjugated Folic Acid to the material prevents to get into the 293 HEK cells FRs-negative overexpressed.
- The FT-IR and XPS spectra confirm the attachment with folate.
- Future work points to more mechanistic investigations of this effect along with identifying additional peptide candidates for enhanced cellular targeting.

V. References

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