Fabrication of Hybridized Nanoparticles with Aggregation-induced Emission Characteristic and Application for Cell Imaging

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Introduction

Fluorescent nanoparticle-based detection platforms are superior to traditional organic dyes because of their sensitivity and stability. Previously, we synthesized fluorogenic bioprobes by attaching a large number of TPE units to a chitosan (CS) chain. The resultant TPE-CS bioconjugates show a unique AIE behavior and excellent performance in cell tracing.

HA nanoparticles, the main component of natural bone, have been used for drug storage due to their porous structure and serve as ideal candidates for both bioimaging and drug delivery because of their good biocompatibility and biodegradability.

Here, TPE-CS bioconjugates are synthesized, and used as a coating agent for negatively charged hydroxyapatite (HA) nanoparticles through electrostatic interactions. Besides, TPE-CS/HA nanoparticles exhibit strong fluorescence and good cytocompatibility, making them well suited for cell imaging.

Method

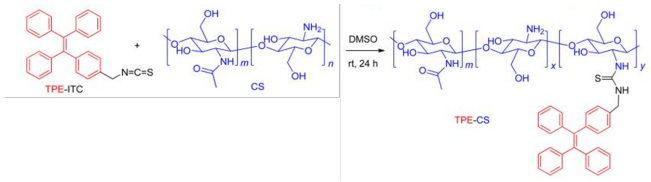

Figure 1. Synthesis of a Bioconjugate of Tetraphenylethene (TPE) and Chitosan (CS)

1.TPE-CS was synthesized by the addition reaction of the isothiocyanate (ITC) group in TPE−ITC with the amino group in CS.

2.TPE-CS/HA nanoparticles was prepared through electrostatic interactions, whose properties were investigated by XRD, XPS, TEM, FL spectra, Zeta potential and Fluorescent photographs.

Results and Discussions

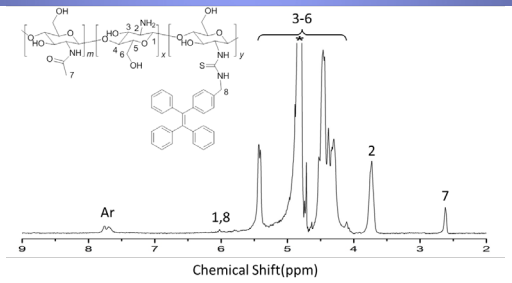

Figure 2. ^{1}H NMR spectra of CS-TPE. The solvent peaks are marked with asterisks.

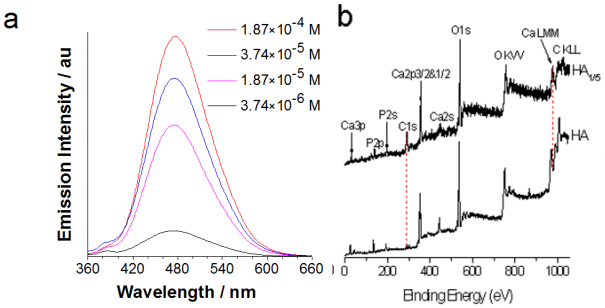

Figure 3. (a) Fluorescence spectra of TPE-CS in 0.1 M acetic acid aqueous solution with different fluorogen concentrations. (b) XPS spectra of $HA_{1/5}$ and HA with no trisodium citrate

Table 1 Size and Zeta potential of $HA_{1/5}$ nanoparticles before and after coating with TPE-CS

Sample	Particle Size (nm)	Zeta Potential (mV)
$HA_{1/5}$ NPs	155.1	-17.39
TPE-CS/$HA_{1/5}$ NPs	111.9	11.51

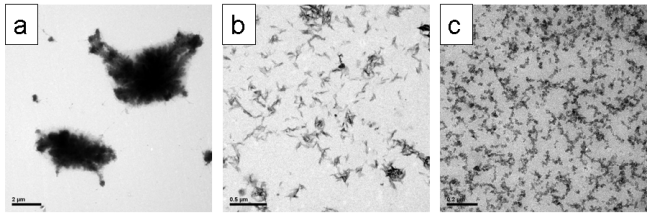

Figure 4. TEM images of (a) $HA_{1/1}$ nanoparticles, (b) $HA_{1/5}$ nanoparticles, (c) TPE-CS/$HA_{1/5}$ nanoparticles.

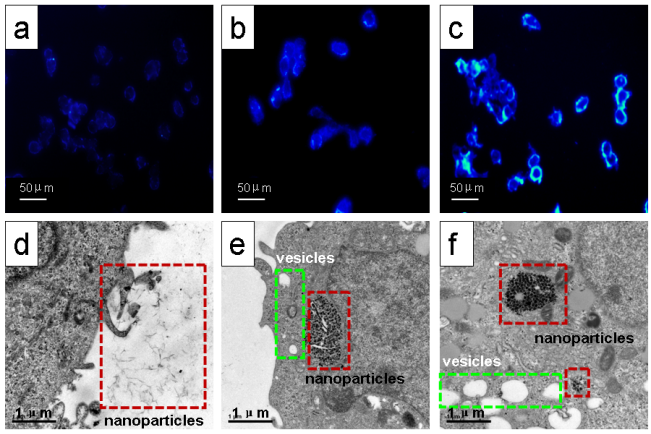

Figure 5 Fluorescent photographs and TEM images of 293T cells after incubation with TPE-CS/$HA_{1/5}$ nanoparticles for different times: (a, d) 1 h; (b, e) 4 h and (c, f) 8 h. TPE-CS/HA nanoparticles are marked with a red dotted box; phagocytotic vesicles are marked with a green dotted box

Conclusion

In summary, TPE-CS bioconjugates with AIE characteristic were synthesized. Needle-like HA nanoparticles were synthesized by the chemical precipitation method. TPE-CS/HA nanoparticles were prepared by electrostatic interactions and were well dispersed in aqueous solution due to the repellency caused by their surface charges. The positively charged TPE-CS/HA nanoparticles are favored for their association to the negative domain of the cell membrane. 293T cells were imaged by TPE-CS/HA nanoparticles, and the particles were first adhered to the cell membrane. Then many more nanoparticles were endocytosed via culture for a long time, resulting in a much stronger fluorescence emission.

Acknowledgements

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References

1. Wang Z, Chen S, Lam J W Y, et al. Journal of the American Chemical Society, 2013, 135(22): 8238-8245.