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Development of A Suitable Surface by Coating with Antibody Modified Up-conversion Nanoparticles for Improvement of Cell Culture Performance

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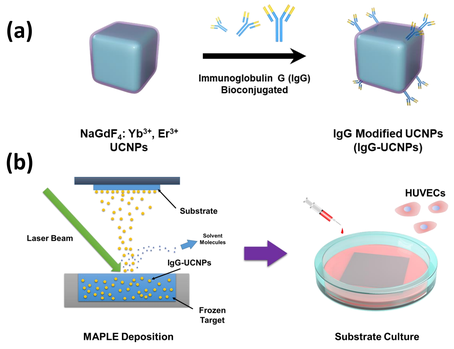
Background

- Researches indicated that nanostructured coatings could have a potential in improving cell adhesion [1]. Matrix assisted pulsed laser evaporation (MAPLE) technique is a contamination-free process that meets the requirements of an efficient process to deposit biopolymer without damaging their backbone on the surface of various substrates [2].
- In this study, up-conversion nanoparticles ($NaGdF_4$: Yb^{3+}, Er^{3+}, UCNPs) with/without immunoglobulin G (IgG) modification were deposited by MAPLE system on the substrates. The nanostructured coatings enhance the adhesion and proliferation of human umbilical vein endothelial cells (HUVECs) and MAPLE is an efficient method in the fabrication of nanostructured biomaterials coating.

Methods

- One-pot synthesized UCNPs deposited by MAPLE system equipped with Nd:YAG laser (λ = 532 nm, v = 10 Hz) on the glass bottom of the culture dish.
- Material characterizations were carried out for UCNPs/UCNPs-IgG before/after MAPLE deposition. HUVEC cells were applied in the cell behaviors study on the effects of different nanostructured biomaterials coating.



Scheme 1. The schematic diagram of (a) The one-pot synthesis and IgG modification of UCNPs and (b) MAPLE deposition process and cell behavior test.

Results

❖ Characterization of UCNPs/UCNPs-IgG

- The average size of cubic UCNPs is 50 ± 8 nm. The UCNPs modified with IgG are cubic shapes with an average diameter of 54 ± 12 nm (Figure 1).
- The X-ray powder diffraction (XRD) pattern of UCNPs (Figure 1c) is consistent with the XRD pattern of cubic phase $NaGdF_4$ (JCPDS 27-0697).

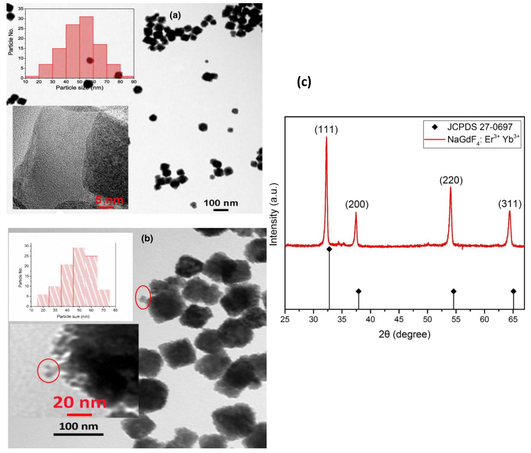


Figure 1. TEM micrographs of (a) UCNPs and (b) UCNPs-IgG before MAPLE deposition. (c) XRD Profile of $NaGdF_4$: Er^{3+}, Yb^{3+} UCNPs.

❖ Characterization of nanostructured coating

- Energy-dispersive X-ray spectrum (EDX) indicates the presence of elements of gadolinium (Gd), erbium (Er), ytterbium (Yb), and fluorine (F) on cell culture dishes, which have a same elemental ratio of Gd:Er:Yb with samples before deposition (Figure 2).
- The peaks at 1575 cm^{-1} and 3648 cm^{-1} in the Fourier-transform infrared spectrum (FTIR) indicate the existence of the coating of UCNPs and IgG-UCNPs (Figure 3).

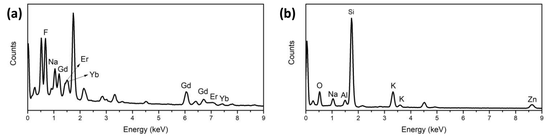


Figure 2. EDX spectra of (a) substrate with UCNPs coating and (b) blank substrate.

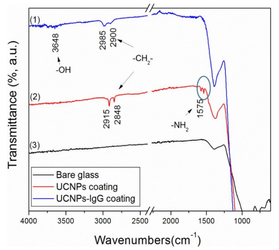


Figure 3. FTIR spectra of blank substrate, UCNPs coating, and UCNPs-IgG coating, respectively.

❖ Cell viability test and cell behaviors on different coatings

- Both UCNPs and UCNPs-IgG coatings impose no toxic effects on HUVECs cells (relative cell viability > 85%).
- The HUVECs cell behaviors on different coatings suggest that the increase of cell area/length/connection (Figure 4) was due to the angiogenesis of HUVECs. Furthermore, results show that could further enhance this process when IgG presents together with UCNPs [3].

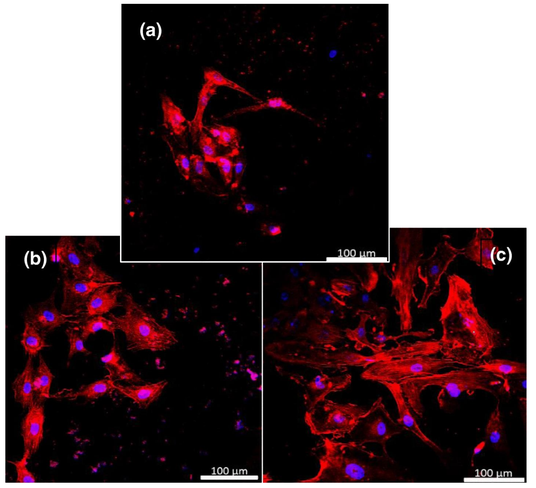


Figure 4. Confocal micrographs of HUVECs on the surface of (a) substrate (control), (b) UCNPs coating, and © IgG-UCNPs coating.

Conclusion

- The results show different behaviors of HUVECs cells cultured on nanostructured coatings and no toxic effect is imposed on cells.
- This study indicates that the nanostructured coatings enhance the adhesion and proliferation of cells and MAPLE is an efficient method in the fabrication of nanostructured biomaterials coating.

Acknowledgement

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References

1. Zhu H, *et al.* (2011). *Biomaterials* 32, 4744-4752
2. Bloisi F, *et al.* (2007). *Mater. Sci. Eng., C* 27, 1185-1190
3. Frigo G, et al. (2016). *Immunobiology* 221, 1329-1342