Functionality of Gold-Edge-Coated Triangular Silver Nanoparticles in Monitoring Extracellular Matrix Protein Conformations in C2C12/MC3T3-E1 Culture in the Presence of Biomimetic Bone Tissue Regeneration Scaffolds

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Introduction

In the cellular environment high noise levels can both mediate and interfere with cellular functions.

The extracellular matrix (ECM) regulates protein dynamics and trajectories, which underpin critical biological processes involved in the development of human disorders and healing processes.

FRET and Raman Spectroscopy are conventional techniques for the study of proteins, however, they are elaborate, and their signals are hindered by the high noise levels of cellular environments.

Noble metal nanoparticles are known to have remarkable optical properties and have been researched for the development of highly sensitive nanobiosensors to study molecules and their interactions in the extracellular matrix.

Gold edge-coated triangular silver nanoparticles (AuTSNP) were validated as a promising new tool to point protein conformational transitions in cultured cells, and to monitor protein activity in the presence of a biomimetic chitosan-based scaffold, since it mimics the ECM as a natural scaffold.

Scaffolds of different formulations were characterised to obtain the strongest construct, with regard to the strength of the linkage formation under photo-crosslinking procedures.

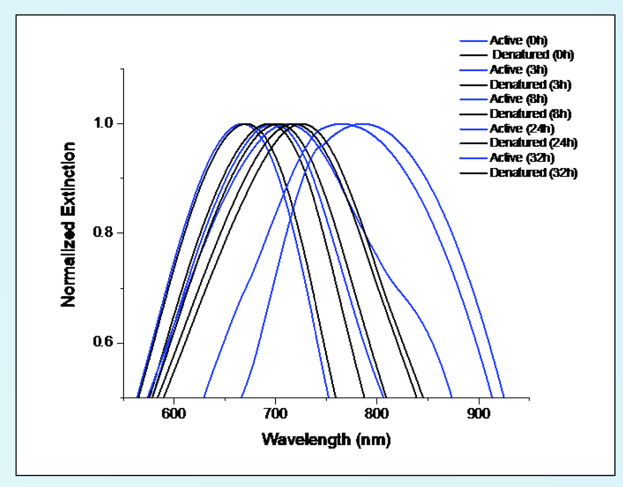
Methodology

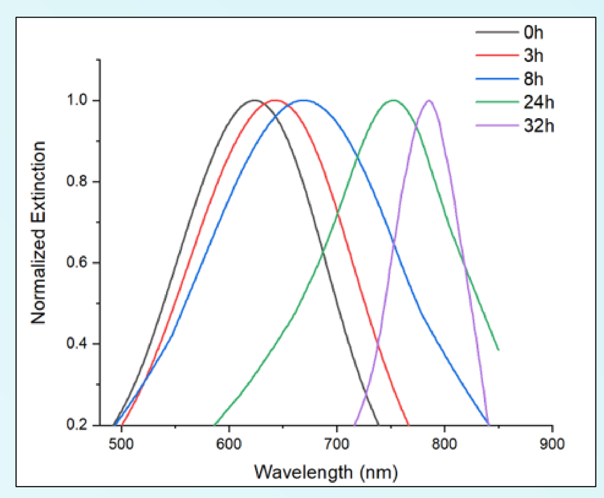
AuTSNP optimization and preparation → Chitosan scaffold preparation and crosslinking characterisation → C2C12, MC3T3 cell culture → Monitoring of Fn in cell culture → Monitoring of Fn in cells + chitosan-based scaffold

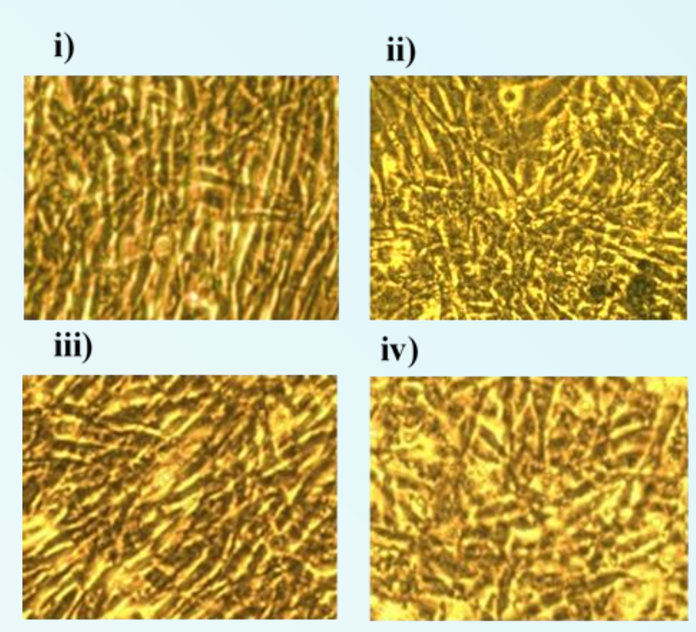
Results

Chitosan-Hydroxyapatite biomimetic scaffold

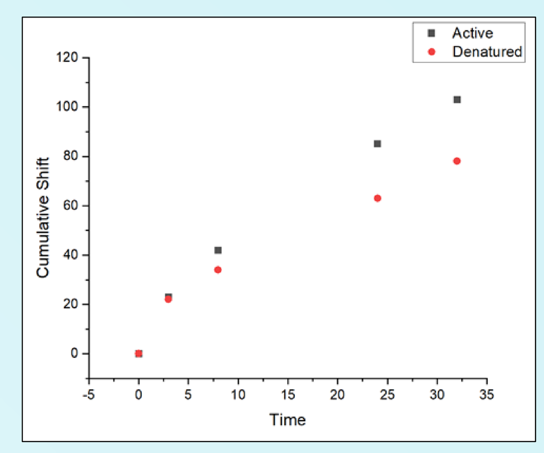
C2C12 +/- scaffold

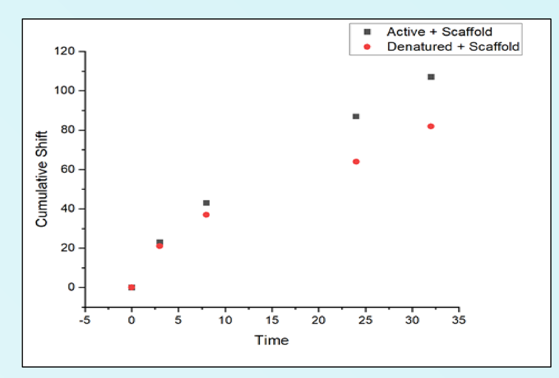


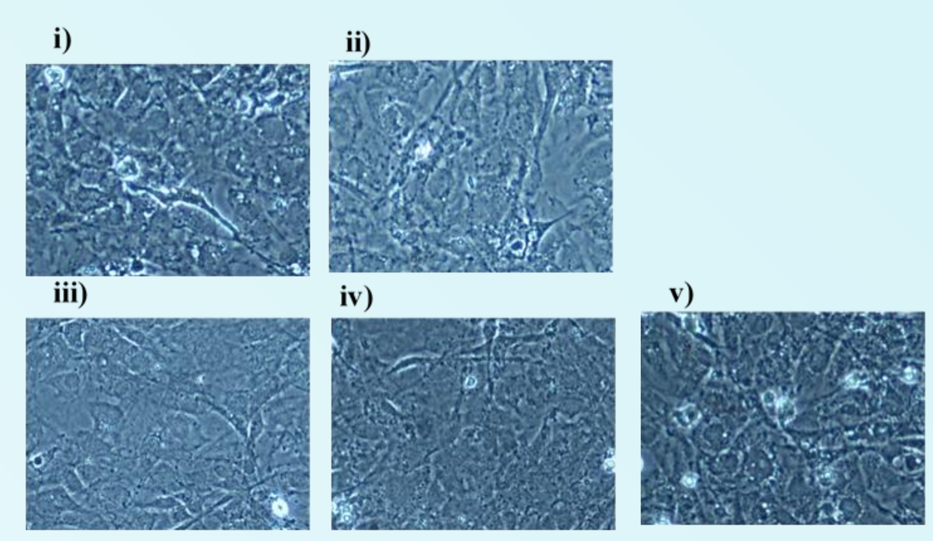




MC3T3 +/- scaffold







Conclusion

Functionalised AuTSNPs performance as Fibronectin (Fn) biosensors in the presence of ECM-mimicking bone regeneration scaffolds was demonstrated. The specificity of the Fn monitoring was confirmed through spectral monitoring denatured and active protein where it was successfully demonstrated that gold edge-coated triangular silver nanoparticles are powerful tools for non-labelling measurements for biomolecule dynamics in high background noise environments such as MC3T3 and C2C12 cell lines. The remarkable sensitivity of AuTSNPs enables their capability to interact with and sense tissue molecular signalling and hence can provide extraordinary possibilities for the development and progression of regenerative medicine.

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