Metallized Clay Nanoparticles for Tissue Regeneration

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Statement of Purpose: Recently, applications of zinc oxide nanostructures have expanded into the field of wound healing and tissue regeneration. Zinc oxide, when used in solitary form or incorporated into other polymer materials, has been shown to inhibit bacterial growth, confer cytoprotection against reactive oxygen species, enhance osteogenesis and angiogenesis and improve cell growth and proliferation both in vitro and in vivo. There is also growing evidence that zinc deficiency significantly delays wound healing conceivably due to a reduction in antioxidant activity of metallothioneins in the affected wound area. This research is based on the hypothesis that coating halloysite nanoclays (HNT) with zinc and subsequent incorporation of the novel zinc-HNT nanocomposite into a chitosan-based polymer wound patch will provide the need mechanical properties and additional functionalities such antibacterial and tissue regeneration.

Methods: Halloysite nanotubes (HNT) were coated with zinc oxide and examined via scanning electron microscopy (SEM) for the electro-deposition of the metal nanoparticles on the surface of HNTs. Further confirmatory tests were carried out using Energy-dispersive X-ray spectroscopy (EDX) and Fourier-transform infrared spectroscopy (FTIR). The coated HNTs were then loaded with gentamicin and then tested for their antibacterial properties against *E.coli* via micro-titration method. The zinc-coated HNTs were then incorporated into a polymer blend comprising of chitosan and carboxymethyl cellulose and examined for cytotoxicity on human dermal fibroblast cells using a CCK-8 proliferation/cytotoxicity assay kit.

Results: The results obtained showed a successful deposition of metal nanoparticles on the surface of HNTs as seen in figure 1.

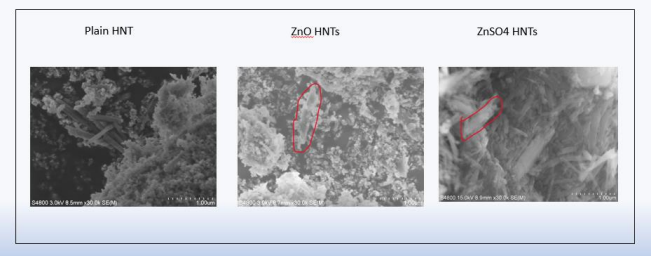

Figure 1: SEM image of Control HNT, ZnOHNT and ZnSO4HNT

The zinc-coated HNTs were shown to be effectively suppress *E.coli* growth as seen in figure 2

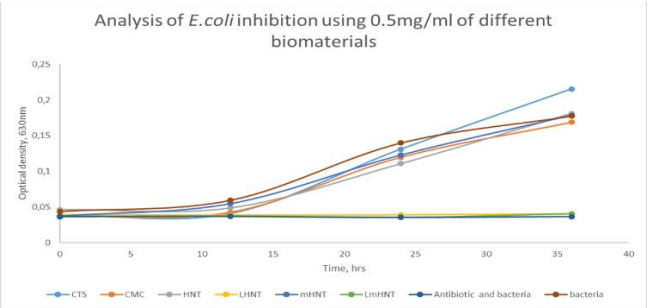

Figure 2: Analysis antibacterial properties of zinc-coated HNTs against *E.coli* over 36 hours

Data obtained from the proliferation test using human dermal fibroblasts suggest that the formulated wound patch was not cytotoxic and did not hinder cell growth.

Conclusions: The outer surface of HNTs were successfully coated with zinc oxide via electrophoretic metal deposition. The zinc-coated HNTs showed effective antibacterial properties by suppressing *E.coli* growth over a 36-hour period. Proliferation tests showed no cytotoxic effect after human dermal fibroblast cells were exposed to Zinc-coated HNTs embedded in a chitosan-based composite. This suggests that the fabricated composite could potentially be used to reduce the risk of developing infections on wound surfaces, thus enhance wound healing and tissue regeneration.