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Microcellular Bio-nanocomposite Foam as Sustainable Bone Scaffold Material

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Abstract—*There is a critical need for developing orthopaedic biomaterials for prosthetic and transplant surgeries. Existing polymericscaffoldssuffer from lack of sufficient mechanical performance and can only provide a two dimensional microenvironment to the cells, whereas in situ environment of a cell consists of a three dimensional biocomposite structure having network of extra-cellular matrix and nanofibres. In order to culture cells in a truly three dimensional microenvironment, the scaffold must be a biocomposite with nanoscale reinforcements and desired mechanical integrity.Against this background, bio-based nanocomposite foam scaffold with three dimensional environment wasdesigned towards developingnew generation orthopaedic biomaterials.Epoxidised soybean oil was used as green resin precursor to develop polyurethane (PU) based microcellular foam scaffold. Nanocellulose derived from agricultural residue provided the environmentally-preferable platform, which was incorporated within the biofoam scaffold to assist in biomimeting three dimensional matrix environment.Transmission electron microscopy (TEM) confirmed the successful fibrillation and synthesis of cellulose nanofibres with average diameter less than 50 nm. Graphene nanoparticles were thermodynamically dispersed into the interpenetrating composite network structure to enhance the energy absorption performance of the composite substrate and to deliver the desired structural integrity. After fabrication, these bioengineered foam scaffolds were undergone microstructural analysis, thermal and thermo-mechanical characterisations, and biocompatibility assessments and the results were compared with tri-calcium phosphate (TCP) reinforced foam scaffold. The preliminary biocompatibility assessments confirmed the nanocomposite foam scaffold as a good candidate material for adhesion and proliferation of mouse fibroblast and human osteoblastscells.It was concluded therefore, that this novel biobased nanocomposite foam scaffold has a great potential to promote cell proliferation and growth which could be an initiative to develop truly bio-mimicked orthopaedic biomaterials.*