



Damian PALIN

Technology Centre: Irish Manufacturing Research (IMR)
Academic Mentor: Professor Daniel Kelly
Company Partner: Roadstone
Company Mentor: Dr. William Wilson

Damian is a Career-FIT PLUS Fellow at Trinity College Dublin, working with Professor Daniel Kelly on the development of Nacrecrete, a nacre (or seashell)-inspired, high-performance, cementitious composite. Previously Damian was a Marie Curie Global Fellow working with both Professor Lara Estroff at Cornell University and Professor Henk Jonkers at the Delft University of Technology (TUD) in the area of bio-inspired material synthesis for construction applications. Damian gained his PhD from the Faculty of Civil Engineering and Geosciences at TUD, under the supervision of Professor Jonkers working on the development of a smart, bacteria-based self-healing concrete.

Professor Daniel Kelly

Professor Daniel Kelly is a world expert in the development of novel biomimetically engineered and 3D bioprinted tissues for regenerative medicine applications in orthopaedics. Prof. Kelly is the Chair of Tissue Engineering in the Department of Mechanical, Manufacturing and Biomedical Engineering at TCD. He leads a large multidisciplinary tissue engineering group based in the Trinity Centre for Biomedical Engineering (TCBE) at Trinity College Dublin (TCD), Ireland. He and his lab have: developed a range of different bioinks capable of supporting distinct cellular phenotypes and used these bioinks to bioprint cartilage and meniscal grafts; used 3D printing techniques to produce fibre-reinforced cartilaginous templates and assessed the efficacy of such constructs in preclinical models of osteochondral defect repair; demonstrated that it is possible to scale-up such processes to regenerate large bone defects, or tissue engineer entire new bones or biological implants for whole joint resurfacing.

Dr William Wilson

Dr William Wilson, the proposed company mentor, is a concrete technologist and expert in the design/fabrication of high-performance concretes and the life cycle assessment of cementitious materials. He currently leads Roadstone's Concrete Research & Development team, focused on the design, testing, assessment and implementation of high-performance real-world cementitious materials. He was a member of the Roadstone team that developed a number of high-performance concrete mixes, including a C80/95 concrete, for the Rosie Fitzgerald Kennedy Bridge, a three-tower, 887 m long bridge in New Ross, Ireland. He received his PhD in Civil Engineering from the Institute of Technology Sligo on the design of sustainable ultra-high-performance fibre-reinforced concretes.

IMR

Irish Manufacturing Research

IMR is a leading Research and Technology Organisation providing a portfolio of research, training and consultancy services to Industry across four thematic pillars: Digitisation, Sustainable Manufacturing, Design for Manufacturing, Automation and Advanced Control.

Roadstone

Roadstone is Ireland's leading manufacturer and supplier of construction materials and, as such, represents the perfect company partner for the Nacrecrete project. Roadstone is a Cement-Roadstone Holdings company. Roadstone offers a range of building and construction products and services, including concretes, mortars, asphalt, paving and roof tiles, providing building contractors, architects and consultants with proven, sustainable solutions that meet the requirements of all relevant building regulations and standards.

Host Institution

Trinity College Dublin

The Kelly Lab at Trinity College Dublin is a leading lab for tissue engineering, particularly for the 3D printing of synthetic bone and hydrogel constructs for orthopaedic therapies. The Kelly Lab is housed in the TCBE, a leading biomedical research centre housing expertise ranging from tissue engineering, biomechanics, and neural engineering (over 30 principal investigators and their labs).

Damian's project

Nacrecrete—A Nacre inspired high-performance resource-efficient Concrete

Concrete is the most widely used material on the planet, gravely impacting the world's resources, energy consumption and carbon dioxide emissions. The European Commission has identified the resource-efficient use of concrete as the primary enabler for realising a sustainable Europe. Nature has long evolved the ability to construct high-performance, resource-efficient materials. Nacre, the lustrous inner lining of seashells, composed of calcium carbonate (chalk) and polymer, is an outstanding example of such a biomaterial. The calcium carbonate, reinforced and structured by the polymer, results in a hard, damage tolerant material at minimal energy and material costs to the organism. The proposed project aims to develop Nacrecrete—A nacre inspired high-performance, resource-efficient concrete. Nacrecrete will be produced by adding a small amount of polymer to concrete to reinforce it and direct its microscale structure. 3D printing will further be used to define the material's overall architecture. These will result in highly structured, hard, damage tolerant concrete, requiring radically less material than standard concrete to achieve the same or greater structural demands. The project will further employ advanced characterization techniques to answer fundamental questions regarding cementitious-polymer interactions, composite structure formations and structure-property relationships.

The Nacrecrete project will partner TCD, IMR, and Roadstone, three of Ireland's leading materials development centres. The project will utilise TCD's expertise and competencies in the 3D printing of biomimetic tissues and bones; IMR's in 3D printing manufacturing; and Roadstone's in the design, production and implementation of high-performance cementitious materials. The project promises to revolutionise the way we build and construct, enabling novel and sustainable building and construction potentialities towards realising a sustainable Europe. The project will promote Irish enterprise and growth and see Ireland/Europe become a global leader in the nascent field of biologically inspired building and construction materials development.

