The NanoGrow project utilized a nano-fabrication coating technique to deposit highly reinforced brick-and-mortar nanocomposites as conformal coatings onto porous foam substrates (illustrated in Figure 1). This processing strategy is a general route for fabricating highly porous, lightweight materials with controlled pore structures and mechanical properties that can be customized to suit diverse applications including scaffold materials for tissue engineering, or lightweight structures for aerospace and transport applications. The project also explored the novel use of cyclic mechanical loading as a processing parameter to target more deposition of thicker coatings in regions subjected to higher loading. This mechanically directed deposition was inspired by the ability of bone to adapt by depositing more material where mechanical loads are higher, leading to more efficient material utilization and better lightweight mechanical performance.

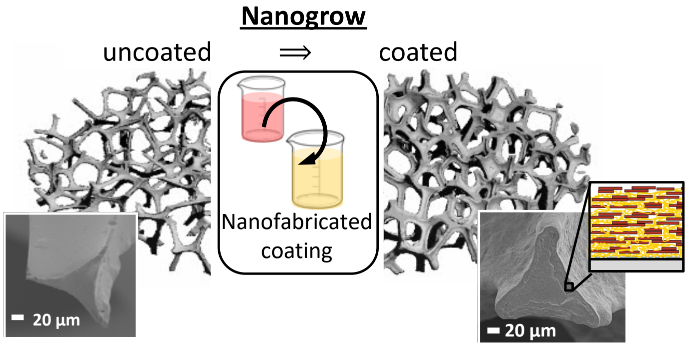

Figure 1. Nanogrow material systems processed by nanofabrication of brick-and-mortar reinforced coatings onto

The NanoGrow Career Integration Grant has enabled this pioneering work by establishing Dr Andrew R. Hamilton, the project leader and Fellow, as an independent researcher in the UK, first as a Lecturer at Queen's University Belfast (QUB), and now as an Associate Professor at the University of Southampton (UoS).

NanoGrow has achieved the following key outcomes:

- Equipment and procedures have been established for implementing nano-fabrication of composite coatings onto substrates with complex three-dimensional pore structures.
- The deposition of nanocomposite coatings was confirmed and the composition, morphology, and properties of the coatings were characterized.
- A micromechanical model was implemented to predict the mechanical behavior of coated foams, was validated against experimental results, and employed as a design tool for coated porous material systems.
- A range of processing conditions were explored and optimized for biomedical and lightweight structural application requirements (i.e. high mechanical properties, high porosity, low density, and fast production time).
- The biocompatibility of nanocomposite-coated foams was characterized for biomedical applications.
- The effects of environmental moisture were characterized and mitigated for biomedical and lightweight structural applications.

- The effect of cyclic mechanical loading on coating deposition rate was explored as a route for mechanically adaptable and self-optimizing materials, inspired by bone.
- A new X-ray microfocus computed tomography (microCT) facility was established at the initial host institute (QUB), and employed for three-dimensional structure and morphology measurements of coated foam materials.
- One post-doctoral researcher, two PhD students, and several Master's students have been trained in relevant technical and transferrable skills.
- Additional external funding was secured from a UK national funder, the EPSRC (Engineering and Physical Sciences Research Council), to supplement NanoGrow activities, and more funding for further work is being pursued.
- Outcomes have been disseminated in multiple conference contributions, journal articles, engagement at public outreach events, and a feature article highlighting research activities to a general audience.

NanoGrow has bolstered research capability in the EU and impacted academic research by establishing novel material systems and fabrication techniques with large scope for further innovation through customized nano- and micro-structured porous materials, and for application as engineered tissue scaffold and lightweight load-bearing materials. Advanced materials are widely recognized as a key enabling technology with large economic and societal impacts by improving performance in aerospace, transport, and infrastructure, by improving treatment and outcomes in health care, and promoting sustainability by lowering carbon footprints & energy demand and limiting consumption of raw materials. The materials studied in this project will help realize this potential through development and characterization for biomedical and lightweight structural applications, and more efficient material utilization through self-optimization. The Fellow continues to advance these outcomes as an established academic in the UK, with active PhD projects and funding applications that are building upon the achievements of NanoGrow.