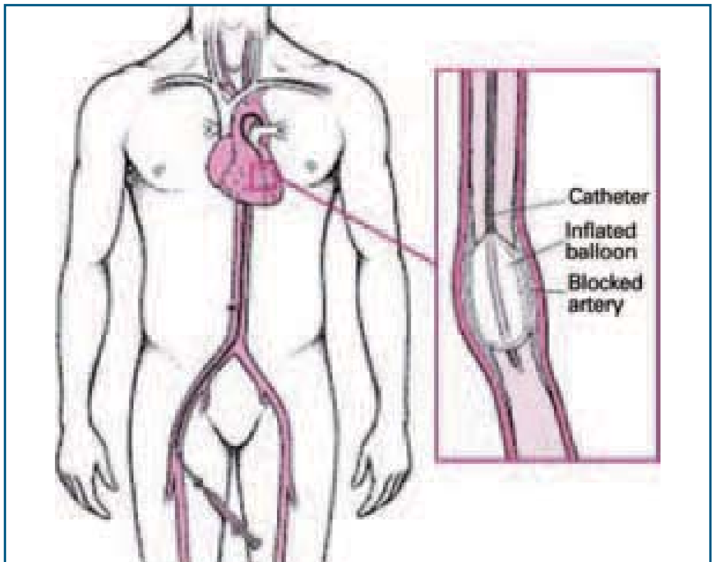
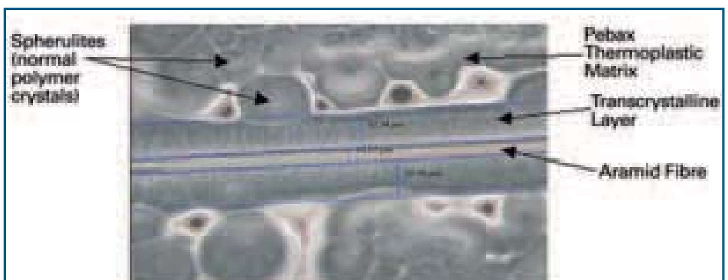
Advanced composites for the medical device industry

More and more diagnostic and therapeutic procedures are now being performed utilising microbore catheters. With the evolution of medical science and the development of new and revolutionary minimally invasive medical procedures, design and performance requirements for small diameter medical tubing have become more demanding and complex.



The path of the catheter along the artery into the blockage

Percutaneous transluminal coronary angioplasty (PTCA) or angioplasty, is a method of treating coronary artery disease. A catheter with a deflated balloon on its tip is put in a narrowed artery segment.
There is a need in biomedical engineering for thin-walled, high-performance structures, which could be used as catheters, or as replacement implants in the body. However, there is a fundamental lack of technology to produce a hollow structure with a wall-thickness less than 0.1 mm. When the wall thickness of a tubing can be reduced, and can perform in an optimal way, it is possible for that tubing to reach other, more difficult-to-access areas of the body such as small bore arteries and neural networks.
Reinforced thermoplastic materials are becoming exceptionally important due to their ease of fabrication and reduced costs of manufacture. The process involves filament winding of thin layers of aramid with a thermoplastic polymer matrix. The objective is to produce high-performance thin-walled polymer structures whose properties are designed, or tailored to the particular application. The behaviour of composite materials is in part controlled by the nature of the interface, which in polymer-matrix composites is usually required to be strong. Understanding and control of interfacial properties is therefore of considerable significance. Due to poor adhesion between aramid fibres and most matrices, aramid fibre composites are characterised by relatively low off-axis properties. To improve the interfacial bonding between the aramid fibres and polymer matrix, a variety of fibre surface modifications have been employed including chemical grafting, plasma treatment, and the use of coupling agents.
Much work has been carried out by Austin Coffey, of the Department of Engineering Technology, in developing processing methods optimising the fibre – polymer matrix interface. Recent findings have shown that it could be possible to use simple optical microscopy as a technique to predict the effectiveness of an interface between a reinforcing fibre and a polymer matrix – instead of embarking on a difficult (and costly) exercise of advanced materials analysis (e.g. Raman spectroscopy and micromechanical analysis).
This was due to the occurrence of transcrystalline regions in the vicinity of the fibres and can occur due to the high amount of nucleation points on the fibre. The degree of transcrystallinity was found to be surface specific. It was found that there was some relationship between the degree of transcrystallinity and the interfacial properties of the composite.
An example of a transcrystalline layer formed around a surface treated fibre is shown below. The degree of transcrystallinity is sizing specific (due to various forms of surface modification).
Previous work has been done by Austin Coffey in this area.
These findings can point to the use of transcrystallinity determination as a potentially valuable technique for the development of future advanced reinforced polymer materials. Applications for these new advanced composites go even further than the medical device industry – encompassing the automobile, aeronautical, and construction arenas.
Further work needs to be conducted to elucidate this characterisation technique, and it is envisaged that this will be carried out at WIT in conjunction with other research centres throughout Ireland and Europe.



Example of the transcrystalline layer formed around an aramid fibre (Succinyl Chloride) embedded in a Pebax matrix

For more information contact:
Mr. Austin Coffey,
E-mail: acoffey@wit.ie