Synthesis and Characterisation of Polyurethane Coatings through Nanoscratch and Non-Contact Optical Profilometry

Abstract:

Polyurethane has found many applications in industry, from medical devices to aerospace. There has been intensive research into the formulation, addition of additives, and improving processing techniques to further develop these materials in order to provide more versatile coatings. Polyurethanes are produced by reacting a polyol with a diisocyanate to form a urethane link. This subunit can further react with another polyol or diisocyanate to produce polyurethane.[1] A polyurethane system composed of 4,4'-diphenylmethane diisocyanate and castor oil has been investigated for both low friction applications (medical devices) and high durability applications with anti-microbial properties (doors and appliance handles).

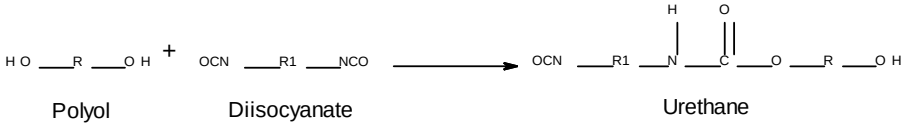

Figure 1: Urethane reaction shceme

Instruments such as the CB500 Nanoscratch mechanical tester and JR25 Optical Profilometer can be used to analyse the physical properties of these polyurethane systems. The nanoscratch utilises a variety of diamond indenter tips to characterise sample hardness, adhesion, coefficient of friction, and surface failure.

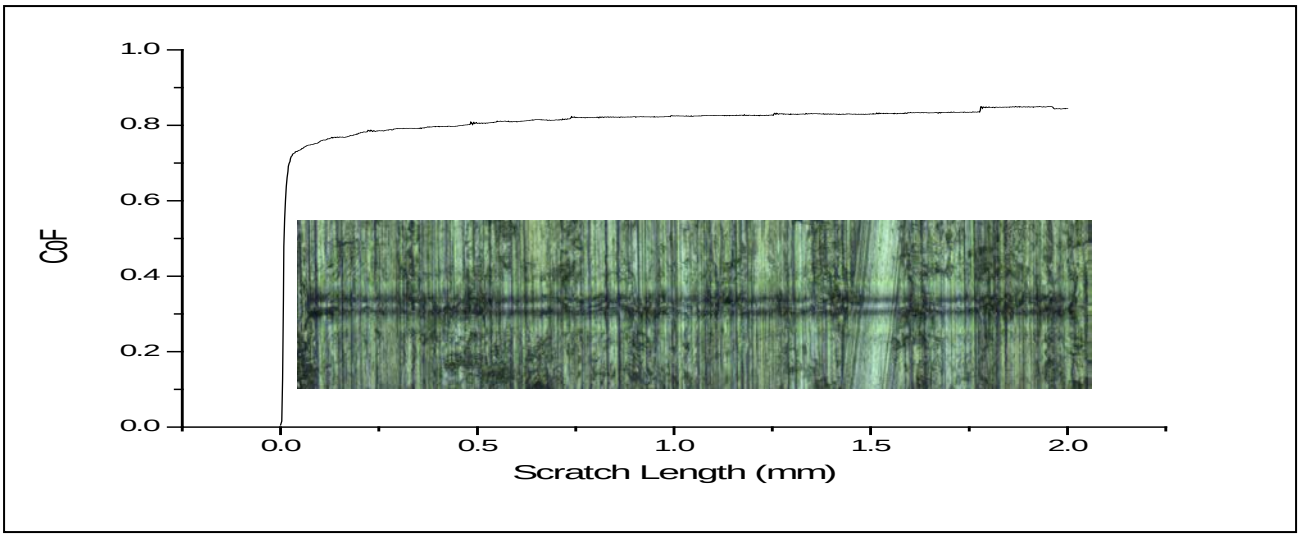

Figure 2: Coeeficient of friction of a polyurethane through nanoscratch technology

The Jr25 is a 3D imaging, non-contact optical profilometer. It utilises white light to obtain height and intensity profiles/area data of a sample's surface. This technique involves separating white light into its colour components, and each wavelength is focused at a different distance. Differential focusing such as this creates a vertical measurement range where these wavelengths of light interact with the surface. As the pen moves along the sample, the height associated with that area is analysed. As the surface of interest is scanned, it will fall within a measurement

[1] G. Tibério Cardoso, S. Claro Neto and F. Vecchia, *Front. Archit. Res.*, DOI:10.1016/j.foar.2012.09.005.

range of a single wavelength and will therefore be in focus whilst the rest of the surface will be out of focus. This newfound focused wavelength will travel back through the pen and reach the CCD spectrometer where it is interpreted to correspond to the vertical height of the surface.

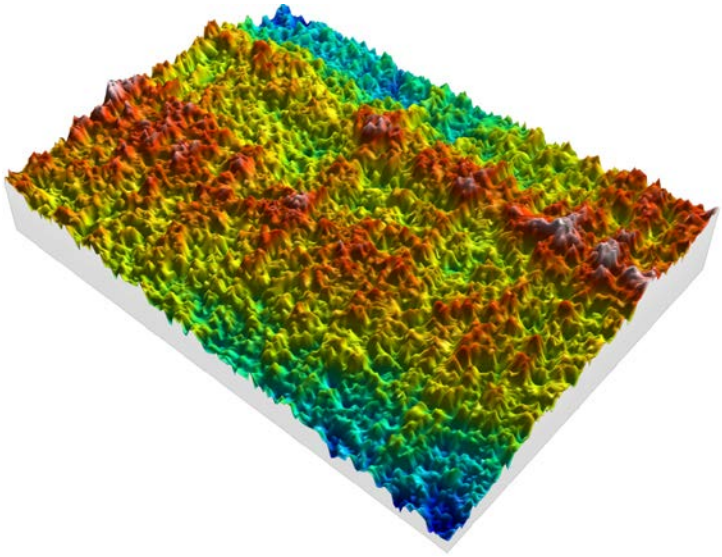

Figure 3: 3D visualisation of polyurethane coating surface

These techniques have been applied to commercial proprietary catheters to evaluate coating performance. Samples are subjected to scratch testing in dry and wet conditions where simulated body conditions are used. Through wet and dry testing, the CB500 has proven to be a very important tool for the characterisation of commercial coatings for the medical device industry.

Industry Aplications:

Polyurethane – A variety of polyurethane coatings are being developed for industrtial applications. As there are many different starting materials with either hydroxyl or isocyanate groups, an assortment of polyurethane formulations can be investigated to provide a multitude of physical characteristics. One particular application for these polyurethanes are low friction, hydrophilic coatings for medical devices.

CB500 – Physical analysis of commercial proprietary coatings for medical devices, and protective automotive coatings. Coeffictient of friction, adhesive failure force (mN), coating hardness (GPa), elastic modulus (GPa), coating failure mechanisms. All tests can be performed in wet and dry conditions for comparison purposes. This is especially important in the medical device industry where wet testing can simulate body conditions to allow for an accurate analysis of the devices performance in real life scenarios.

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