October 2021

Application of micro Vickers hardness testing to polypropylene

Hao Wu[a], Foram Dave[b], Muhammad Mahmood Ali[b], Mozaffar Mokhtari[a], Richard Sherlock[b], Alistair Mcllhagger[a], David Tormey[b], Shaun McFadden[a]

[a]Faculty of Computing, Engineering, and Built Environment, Ulster University, UK
[b]Department of Mechanical and Manufacturing Engineering, Centre for Precision Engineering, Materials and Manufacturing Research (PEM), Institute of Technology, Sligo, Ireland

Abstract

Micro Vickers hardness testing is commonly used as a method to quantify resistance to permanent plastic deformation of metals by using indentation of the surface. Due to the viscoelastic nature, the application of micro Vickers hardness testing to polymeric materials is difficult to interpret and, therefore, is uncommon in practice. Other aspects associated with micro hardness testing, namely, mounting, grinding, and polishing of samples present additional technical challenges for polymers. Nevertheless, if properly characterised for a specific scenario of interest, the application of micro Vickers hardness to polymers is useful. This study reports on a study that has improved the processes involved in preparing polypropylene for micro Vickers hardness testing and proposes a method for selecting measurement parameters when testing the polymer samples. It was shown that the hardness measurement had a strong dependence on the applied load used in the test and on the dwell time of the load. Through comparing the hardness values measured from the benchtop hardness tester against measurements taken on an optical microscope, it was suggested that the most reliable results were obtained from the optical microscope when measurements were taken up to (and within) 24 hours after the indent had been made. An empirical model was developed after fitting to the measured data that showed the relationship with dwell time for different applied load levels. For future work using micro Vickers hardness testing of polypropylene, an applied load of 5 gf and a dwell time of at least 60 s, are recommended.