

Measurement and prediction of compressive properties of polymers at high strain rate loading

Abstract

Strain-rate effect is widely recognized as a crucial factor that influences the mechanical properties of material. Despite the acknowledge importance, the understanding of how such factor interact with the sensitivity of the polymers in terms of mechanical properties is still less reported. In this study, an experimental technique, based on the compression split Hopkinson pressure bar, was introduced to perform high strain rate testing, whereas, a conventional universal testing machine was used to perform static compression testing, to experimentally investigate the independent and interactive effects of strain rates towards mechanical properties of various polymers. Based on the experimental results, we parameterized two equation models, which were used to predict the yield behavior of tested polymer samplings. The experimental results indicate that, the yield stress, compression modulus, compressive strength, strain rate sensitivity and strain energy increased significantly with increasing strain rates for all tested polymers. Meanwhile, the yield strain and the thermal activation volume exhibit contrary trend to the increasing strain rates. Interestingly, the proposed constitutive models were almost agreed well with experimental results over a wide range of strain rate investigated. Of the three polymers, polypropylene shows the highest strain rate sensitivity at static and quasi-static region. On the other hand, at dynamic region, polycarbonate shows the highest strain rate sensitivity than that of polypropylene and polyethylene. Overall, both experimental and numerical models proved that the mechanical properties of polymer show significant sensitivity and dependency towards applied strain rates up to certain extent.