On biaxial experimental characterizations of soft polymers

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Abstract

Soft polymeric materials such as elastomers and hydrogels have played a significant role in recent interdisciplinary research. They are subjected to large stretch and high cyclic loading-unloading conditions where the typical loading mode is biaxial rather than simple uniaxial loading thus, necessitating further characterization using biaxial loading conditions and subsequently developing robust and versatile numerical models. Although many standards were prepared for common uniaxial tests in situ elastomers including tensile, shear, and fatigue tests, no specific standardized guidelines were prepared to be employed for the biaxial characterization of elastomers and hydrogels. There existed limited works on the biaxial characterization of soft polymers, thus making it difficult to identify which configurations and results are more reliable. Hence, there were huge discrepancies in the existing literature for biaxial tests in terms of sample configurations (square or cruciform specimens), dimensions, and test setups including strain rate, pre-loading, equi-biaxial and unequi-biaxial tests. Therefore, this paper is aimed at reviewing the published studies on the biaxial characterization of soft polymers in several aspects including (i) sample configurations in terms of geometry and dimension (ii) biaxiality degree of tested specimens where sample should be optimized to reach proper biaxiality, i.e., larger area with homogenous strain distribution in the middle with respect to the edges, (iii) test procedure for the biaxial characterization including strain amplitude, strain rate and loading patterns (iv) a brief review on inflation test of elastomers which was the most common equi-biaxial test studied in the literature. The largest and smallest cruciform samples with the dimensions of 165 × 165 mm^2 and 38 × 38 mm^2 were used, respectively, while a small sample of 7 × 7 mm^2 and large one of 70 × 70 mm^2 were also employed for the square specimen. Various test parameters and materials were used for the biaxial characterization. This necessitates the importance of preparing a standardized methodology for the biaxial characterization of elastomers based on intended materials and applications. Hence, a few potential geometries based on the optimization performed in the literature were suggested for future investigations in which numerous examinations using different materials and test parameters shall be conducted to reach an ideal sample configuration and methodology for the biaxial characterization of soft polymeric materials.