ABSTRACT

This study was conducted on different types of polymers, namely poly-tetra-fluoro-ethylene (PTFE), poly-ether-ether-ketone (PEEK), polypropylene (PP), high-density polyethylene (HDPE), polyvinyl chloride (PVC) and poly-methyl-methacrylate (PMMA). A comparison between two multi-cycle indentation methods, i.e., Progressive loading multi-cycle (PLMC) and Constant load multi-cycle (CLMC), was done in this study. PLMC is a better method for evaluating surface properties with a load of more than 0.5N and a minimum of 5 cycles. It also avoids the error results coming on shallow indentation load or displacement. But the CLMC can be used to find some other surface properties using the repeated cycle, such as creep, fatigue, etc. In constant load multi-cycle scenarios, the input parameters must be selected with an equal loading and unloading rate of more than two times the maximum load.

Two empirical exponential relations have been created to estimate the material's fatigue cycles and creep displacement using micro-indentation. The fatigue life of the selected materials was determined from hardness (*H*) and loading cycles (*N*). CLMC was used to determine creep using maximum load hold time data. A further relation characterizes these materials' fatigue toughness and back creep or thermal drift. Material properties, indentation properties, and experimental variables define these polymer models.The scratch test data was used to develop correlative models for polymer surface attributes including hardness and elastic modules. These models depend on tangential force, residual depth, recovery rate, scratch width, etc. With these two mechanical properties evaluation models, two more relations were developed to calculate material wear and friction from the same scratch test. The scratch load, speed, and number of passes determined these two tribological property evaluation models.

Researchers take advantage of fewer tests to determine several material properties. Thus, many tests in different instruments for different attributes save time, effort, and money while reducing experimental setting variation and machine error. Using least square curve fitting, these separate models quantified the materials' mechanical and tribological properties. All these models are tested and correlate well with experimental and simulation data. These validation results provide a reliable, exact, and practical methodology to determine polymer surface characteristics from scratch.

Keywords: Non-destructive methods, Polymers, Mechanical Properties, Tribological Properties