Process characterisation of soft-tooled micro-injection moulding through X-ray computed tomography and laser-scanning-confocal microscopy

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Abstract

This study introduces X-ray computed tomography (XCT) as a method for ensuring the dimensional quality of micro-injection molded polymer test specimens and characterisation of soft-tooled micro-injection moulding process. The purpose is to establish predictive quality models and quantify the deformation of soft molds used in rapid prototyping applications. The results are compared to those obtained using an industry-standard laser scanning confocal microscope (LSCM) to assess XCT's capabilities. The research demonstrates the following: (1) XCT equipment can effectively characterize the dimensions of micro-injection molded polymer products within reasonable acquisition times. (2) XCT data, obtained through 3D visualization of micromoldings, performs comparably to a laser scanning confocal microscope when used in quality prediction models. (3) XCT can quantify the deformation that occurs in soft molds created through additive manufacturing. XCT proves to be particularly superior in acquiring volumetric data compared to LSCM when predicting the filling quality of the micromoldings. The study achieves up to a 92% accuracy and repeatability in predicting the quality of the moldings when using XCT in conjunction with in-line collected soft mold surface temperature data as an indirect quality assurance method.

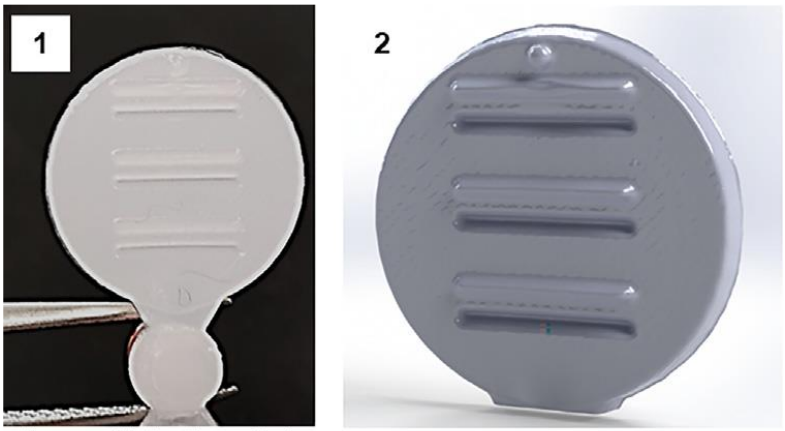

Figure 1: Micromoulded object (1), and XCT scan of the same moulding (2).