Mechanical testing of micromolded plastic parts by nanoindentation

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Weld lines have always been an unavoidable drawback of the injection molding process. With quantities and locations inherently linked to the polymer flow pattern in the impression, weld lines, when located at the areas subjected to load in service, besides the cosmetic defects, may threaten the molded part structural integrity. This is especially true for micro molded parts, where weld line position and its severity can be seen as an indicator of the polymer fluidity as the flow front progresses away from the gate part of the micro impression. Several techniques, both, qualitative and quantitative but destructive, have been employed for assessment of the weld line tensile strength.

As an alternative, nanoindentation offers the possibility for quick quasi-non-destructive in-situ testing, allowing for monitoring the changes that occur in the surface layer of a plastic micro part. In this study, a methodology for the assessment of the superficial properties such as hardness H and reduced Young's modulus Er of micro-molded parts was established. The micro parts, molded from Polyoxymethylene with two different sets of processing conditions were tested throughout the entire length and in the vicinity of the welding line.

The observed hardness H and reduced Young's modulus Er suggest that there is a steady increase in both values along the weld line from the adjoining flow front point at the inner side of the micro part towards the outer edge. In addition, H and Er were found out to vary consistently with the alterations induced on the processing conditions. To complement this approach, the weld line severity (width) assessed by optical microscopy, indicated that the narrowest weld line width was obtained by molding with high levels of the injection velocity, mold and melt temperatures, which contribute positively for intermixing of the polymer fronts and consequently, lessen the probability of micro parts failure when subjected to mechanical solicitations.

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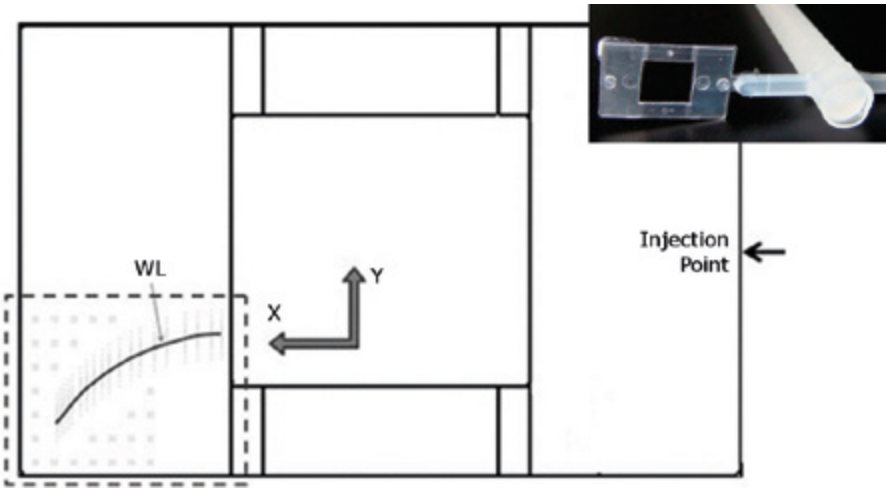

FIGURE 1
Illustration of a micromolded plastic part analyzed by nanoindentation for weld line location.