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WARPAGE OF INJECTION MOLDED IN-MOLD LABELING PARTS

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Decades ago, injection in-mold labeling (IML) has been established and ranks nowadays among the most advanced manufacturing technologies in the area of plastic packaging. Nevertheless, only the limited number of scientific studies on e.g. the warpage behavior of IML parts has been conducted and published. By this manufacturing technique, label and packaging, both are of the same polymeric material, become inseparably connected during the injection molding process. Main advantage of the injection IML is the integration of a follow-up step into the injection molding process. The heat transport reduction owing to the label and the associated slightly higher molding cycle time are some unfavorable aspects of this molding technique. By back molding of polymer melt into a cavity preloaded with a label, it can occasionally come to the situation that the label is folded, slipped, or shifted from its starting position, whereby the injected IML part becomes useless. In addition, the thermal conductivity of the label material is significantly smaller than that of the metal mold wall, consequently thermally induced warpage of injected IML parts or surface deformation could occur. In this study, structure and warpage behavior of IML parts, which greatly differ from those of conventional molded parts without labels were intensively investigated. It was found that it is the volume contraction difference between label and substrate that forces IML parts to warp to the substrate side. In addition, IML part warpage problem can be practically coped by varying the mold temperature on the stationary and moving mold platen. By increasing the mold temperature on the label side, the degree of IML part warpage can be reduced with acceptable reduction in mechanical properties. The optimum mold temperature range for particular substrate material, however, was found to be more decisive in maintaining the modulus of elasticity of IML parts than the magnitude of mold temperature difference.