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A New Plug Concept to Optimize the Thickness Distribution of Thermoformed Parts

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In thermoforming, a heated plastic sheet is stretched into a mould cavity due to applied pressure, eventually assisted by direct mechanical loading. Since upon its contact with the mould's cold surface the sheet is prevented from undertaking any further deformation, the forming sequence induces a thickness variation in the final part. Plug assist thermoforming is widely used to produce deep-draw containers for the packaging industry. The plug improves the thickness distribution by stretching and pushing the heated thermoplastic sheet towards the bottom of the cavity before it touches the mould walls. Nevertheless, due to the viscoelastic nature of polymers and the interaction between plug and plastic sheet, the parts thus obtained exhibit an over thickness both in the bottom and in the lower sides, in relation to the remaining volume. This work presents a methodology to improve the final thickness distribution of thermoformed parts, which can also be adapted to different part contours. The plug contains concentric layers with independent movements. By setting properly the displacement of each layer, more uniform parts can be obtained. Computer predictions and experimental results will demonstrate the usefulness of the concept, as well as the influence of operating and geometrical parameters on thickness uniformity.