

## Optimization of Pulsating Blank Holder Force for Deep Drawing of Cylindrical Cups

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### Abstract

A further improvement in the drawability may lead to a further light-weight cylindrical drawn cup, hence to a more environment-friendly and sustainable industrial product such as an aluminium beverage can & bottle.

A pulsating blank holder force (BHF) with a frequency ranged from ultra-high to ultra-low values, is reported that can improve the drawability, as compared with a static constant BHF. However, it still needs a lot of efforts before applying the pulsating BHF industrially, for example, investigation into the optimum property of vibration added to the blank holder during deep drawing of cylindrical cups.

This study implemented an optimization on the properties of the vibration such as the oscillation amplitude, frequency and phase, by applying the structure optimization technique, based on numerical simulations of the cup drawing process. Parameters used to determine a sinusoidal vibration wave are taken as design variables. Wrinkling and tearing are major defects in deep drawing, therefore are considered as design constraints. The limit drawing ratio (LDR) is one of indicators to evaluate the drawability, therefore LDR is maximized through maximizing the limiting drawing depth that could be achieved for a specified drawing ratio. A sequential approximate optimization method is successfully applied to perform design optimization, which leading to a satisfied improvement in the drawability.

**Keywords:** Deep drawing process, Formability, Cylindrical cup, Pulsating blank holder force, Optimum design.