Accepted Manuscript

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PII: S0141-3910(17)30253-7

DOI: 10.1016/j.polymdegradstab.2017.08.021

Reference: PDST 8332

To appear in: *Polymer Degradation and Stability*

Received Date: 13 June 2017

Revised Date: 28 July 2017

Accepted Date: 15 August 2017

Please cite this article as: Bagudanch I, Centeno G, Vallellano C, Garcia-Romeu ML, Revisiting formability and failure of polymeric sheets deformed by Single Point Incremental Forming, *Polymer Degradation and Stability* (2017), doi: 10.1016/j.polymdegradstab.2017.08.021.

Revisiting formability and failure of polymeric sheets deformed by Single Point Incremental Forming

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Abstract

Single Point Incremental Forming (SPIF) has been intensively investigated in the last two decades. It is a versatile and economical manufacturing technology that is especially viable for small and medium-sized batches, with a great potential for manufacturing highly customized parts. One of the most important advantages of this technology is the greater formability it can attain compared to conventional sheet forming processes. The aim of this paper is to evaluate the overall formability of a series of polymeric sheets deformed by SPIF process, including biocompatible and non-biocompatible materials, while considering a variety of process parameters including *spindle speed* which, in previous studies on polymers formed by Incremental Sheet Forming (ISF), has been shown to be the most influential process parameter. The results show that variations in spindle speed caused a variation in the forming temperature and the material forming limits. For a better understanding of the deformation mechanism and the failure process of polymers during SPIF, a fractographic analysis using optical microscopy was carried out, as well as a Differential Scanning Calorimetry (DSC) analysis to determine the glass transition and melting temperatures and the degree of crystallinity of the polymers.

Keywords: Incremental Sheet Forming, Formability, Failure, Thermal properties, Polymers

1 Introduction

Incremental Sheet Forming (ISF) has been recognized as a process that has the potential to change radically the production system involved in manufacturing prototypes, small batches or customized sheet products. The evolution of ISF and the different varieties, applications and advantages, as well as the process parameters affecting it have been comprehensively described in a series of review and state-of-the-art research papers [1–4]. Additionally, ISF has been shown to be a more environmentally friendly process compared to conventional technologies [5]. As a result, during the past few decades, ISF has attracted the attention of numerous research groups trying to overcome the various problems that limit the more widespread use of the technology as a manufacturing process.

Formability is a measure of the degree to which a certain material can undergo plastic deformation before failure occurs. With the aim of evaluating formability in ISF, several researchers have used