

Introduction

Deep drawing of aluminium and zinc coated steel is an extensively used process in automotive and aerospace applications. In such a process, a good surface quality is often desired.

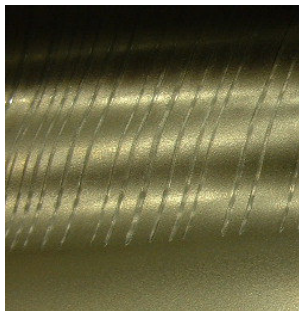


Figure 1: An example of a severely scratched product.

Galling

Galling is defined as the mechanism in which material transfer takes place from the sheet to the tool. That forms work hardened lumps on the tool, which scratches into subsequent products, see figure 1.

Objective

Development of a galling model which is focussed on the contact of a tool and a metal sheet. This model will be implemented as a Galling Performance Indicator (GPI), which will be coupled to FEM simulations of sheet forming processes to predict galling phenomena.

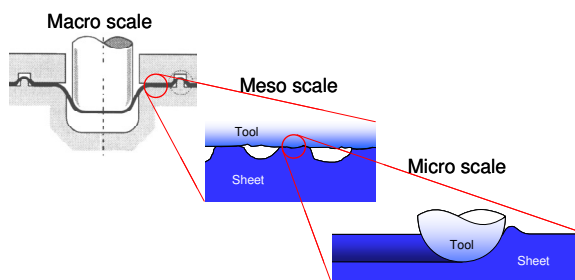


Figure 2: Contact in deep drawing on different scales.

Methods

Contact in deep drawing can be divided into different scales, see figure 2. FEM simulations are typically concentrated on the macro scale, while galling plays a role on the smaller scales. On the meso scale, the relatively rough sheet is flattened when it is in contact with the smooth tool and plateaus are formed on the sheet. On the micro scale, the hard tool asperities plough through the flattened sheet plateaus. These ploughing asperities pick up material from the sheet metal.

- Experiments are performed with a spherical shaped tip of tool material which scratches against a metal sheet, in order to simulate the micro scale behaviour. From these experiments the growth behaviour can be studied, see figure 3a.

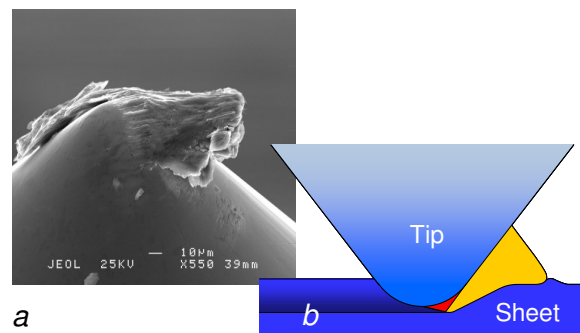


Figure 3: a) A SEM picture of a tool steel tip which ploughed against aluminium sheet. b) a schematic view of the experiment.

- From experiments and calculations it follows that under certain conditions material is pushed forwards in front of the tip. During lift up of the tip, a part of the pushed material is attached to the tool material and the rest remains on the sheet, shown as respectively the red and the orange region in figure 3b.
- The research now focuses on the ploughing behaviour in combination with adhesion, in order to model the amount of material attached to a tool asperity.