Warm Formed Magnesium Case

Background:

Magnesium alloys can provide great weight reductions in components, which would otherwise be made from steel or polymeric materials. Those used in current structural parts tend to be die-castings, which are prone to porosity and are usually quite bulky in nature. Manufacturing thin sections from die-castings has proven difficult and expensive. Formed magnesium alloy sheet offers an alternative with good mechanical properties but has low formability at room temperature.

Between 200 and 300 degrees C, thin magnesium alloy sheet exhibits good formability due to the activation of additional slip planes in the alloy's hexagonal closed packed lattice. figure 1 shows how the flow stress of a magnesium sheet drops to almost 1/3 of the room temperature value at 235 degrees C. Exploiting this increased formability at warm temperatures could result in an increased useage of magnesium sheet in automobile, electrical and electronic applications.

The Process:

Aida Engineering Ltd. devised a unique production sequence to warm form magnesium alloy sheet into the laptop computer case shown in figure 2. Manufacturing involved four stages: blanking, warm forming, cooling and trimming. Heating of the blank, as required in this process, is not part of a conventional stamping process. An economical heating method was achieved by incorporating cartridge heaters in the forming tools. The tooling is heated to 300 degrees C and the magnesium sheet is clamped between the punch and die for 3 seconds. The forming process also employs a servomotor driven press, which provides a slow ram speed to form the sharp corners of the laptop case, followed by a rapid movement to maintain a reasonable production cycle lasting 6 seconds.

Simulation:

DEFORM™-3D was used to model the forming process. The setup of the simulation is shown in figure 3. The heating and warm forming of the laptop case were simulated with the initial temperatures of the punch, die and pad set to 300 degrees C. The initial temperature of the blank and environment were set to room temperature.

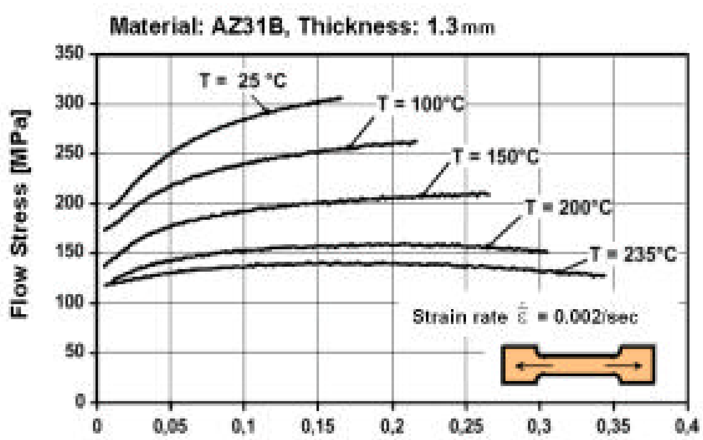

Figure 1: The flow stress of magnesium alloy AZ31B decreases with increasing temperature [Droder 1999].

Figure 2: The Mg alloy stamped laptop case is shown.

DEFORM™
Design Environment for FORMing

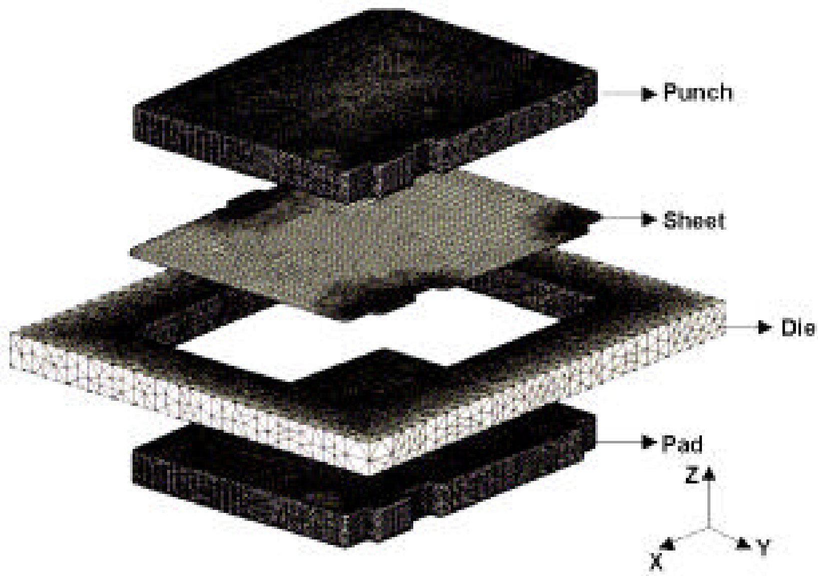

Figure 3: DEFORM-3D model of the warm forming process is shown as four objects.

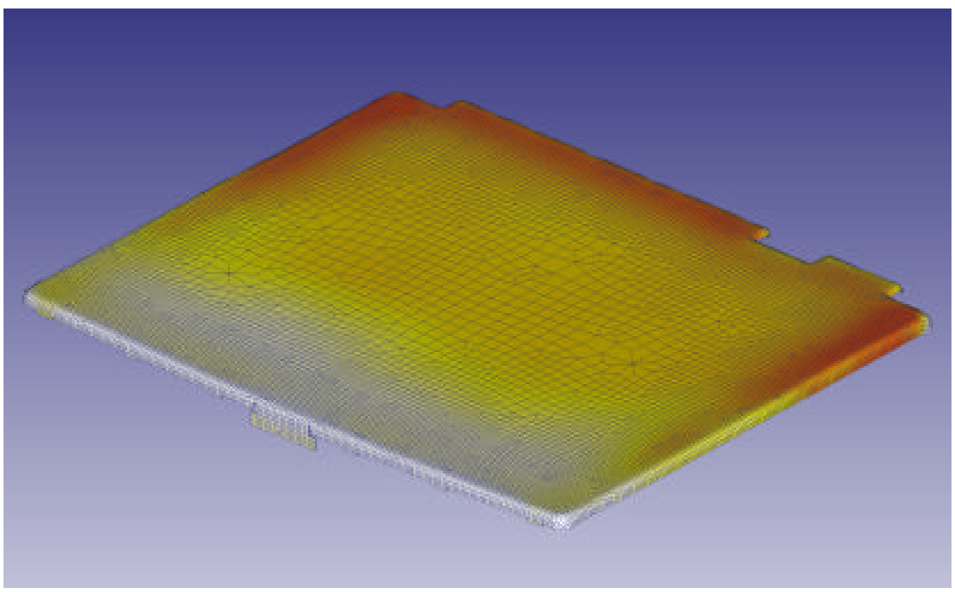

Figure 4: A DEFORM-3D prediction of temperature distribution at the end of the forming stroke (white is hotter) is shown with the brick mesh.

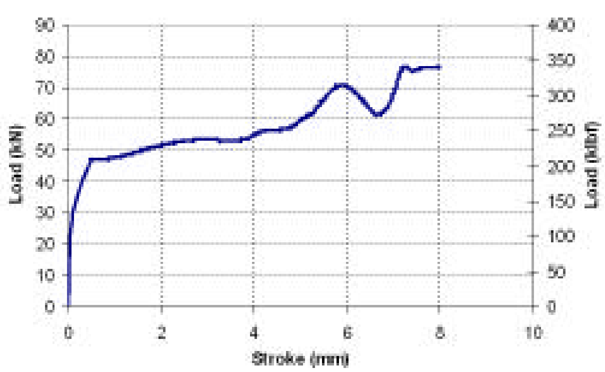

Figure 5: The predicted load-stroke curve is shown.

Results:

After 3 seconds of heating the blank in the tooling, DEFORM™ predicted the temperature distribution prior to forming. Areas in contact with tooling reached a temperature of 295 degrees C. The non-contacting locations reached a temperature of 265 degrees C. The predicted temperature distribution at the end of forming is shown in figure 4. The maximum temperature had increased to 310 degrees C in the corner locations due to adiabatic heating and greater contact with the tooling.

Forming Load:

The simulated load-stroke curve is illustrated in figure 5, where it can be seen that a maximum punch force of 75 kN was predicted. From the flow stress curves in figure 1, it is evident that the same product at room temperature would require far greater forming loads.

Acknowledgements:

The simulations were conducted at the Ohio State University - Engineering Research Center (OSU/ERC), in conjunction with Aida Engineering.

Scientific Forming Technologies Corporation

5038 Reed Road
Columbus, Ohio
43220-2514
Tel: (614)451-8330
Fax: (614)451-8325

www.deform.com

email: sales@deform.com