Electromagnetic Embossing of Optical Microstructures with High Aspect Ratios in Thin Aluminum Sheets

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Abstract

Electromagnetic embossing enables the transfer of surface structures from forming dies to metal sheets at high forming speeds. For this purpose, the contactless forming force is provided by means of a magnetic field of a tool coil which interacts with an eddy current in the workpiece. In thin sheets which are completely penetrated by the magnetic field, the resulting Lorentz forces act as body forces that accelerate the workpiece onto the forming die. In addition to the body forces, also high strain rates can support the embossing of thin sheets.

This investigation deals with the embossing of pyramidal structures in the submillimeter range and an aspect ratio of about 1 into thin aluminum sheets (3.0255 / Al99,5). In order to quantify the reproduced microstructures, their extent is determined by means of a lateral analysis. From this, the replicated height is derived. Up to now it has been possible to partially reproduce microstructures with a large aspect ratio in thin sheets. In addition, the changing surface roughness of the sheets is taken into account. Before embossing, the sheets exhibit a relatively rough surface with a rolled texture, which is smoothed by the impulse forming with an optical forming die. This study reveals basic approaches for the electromagnetic embossing of optical microstructures.

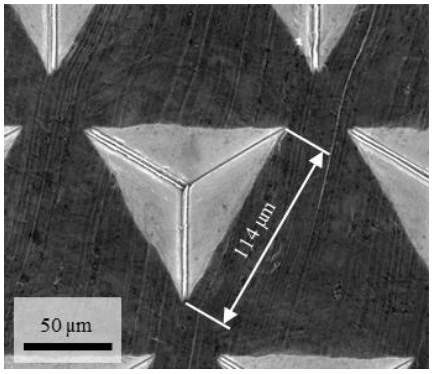

Figure 1: Scanning electron microscope (SE-sensor) images of the largest structures achieved for embossing strategy: 3 incremental pulses