Special Feature: Metal Forming and Processing

Overview

Shinji Mitao
Department Manager
Material & Processing Dept. I

Significant research and innovations, including a number of smaller advances that are put to use in our daily lives, have advanced global environmental conservation and energy savings. Weight reduction is a simple and effective approach to improving automotive fuel efficiency. In recent years, steel has been replaced with lightweight materials, such as aluminum and magnesium alloys and plastics. Steel has excellent mechanical properties, well-established working techniques (such as welding), good recyclability, and economic advantages. For Earth-conscious lightweight cars that are economically competitive, the most appropriate multi-material structure is worth considering. In addition, it is extremely important to maximize the benefits of any material. One of the basic techniques to bring out the potential of structural materials is microstructural control, which is usually achieved by alloy design and process control. For example, strengthening of materials usually enables weight reduction through the downsizing of parts. However, the strengthening of materials usually involves a number of technical considerations, such as the trade-off relationship between strength and ductility. Continual challenges in manufacturing technology, including microstructural control, are absolutely necessary for tomorrow's earth-friendly multi-material cars.

This special issue includes four technical papers on forming and processing to bring out the potential of metallic materials through microstructural control and/or the analysis of plastic deformation behavior. The first paper introduces a thermodynamic simulation for the growth and dissolution behavior of grain-boundary cementite during vacuum carburizing of case-hardened steels, which greatly influences the hardness of carburized parts. The second paper describes the non-equilibrium solidification behavior in an Al-Si eutectic alloy at various cooling rates. The third paper examines finite element (FE) modeling to predict surface deflection in press forming of automotive outer panels. Applicability of the developed model to the restriking process was confirmed by the actual press forming. Finally, the last paper deals with the measurement of flow stress in metallic materials over a large strain range, which cannot be evaluated by the conventional mechanical testing. The obtained data are used for the numerical analysis of deformation behavior in press forming or forging.