Experimental and Simulation Aspects Regarding LM6/Sicp Composite Plastic Deformation under Different Frictional Conditions

H. Joardar, Department of Mechanical Engineering, C.V Raman College of Engineering, Bhubaneswar, India

N.S. Das, Department of Mechanical Engineering, C.V Raman College of Engineering, Bhubaneswar, India

G. Sutradhar, Department of Mechanical Engineering, Jadavpur University, Kolkata, India

S Singh, Department of Mechanical Engineering, KIIT, Bhubaneswar, India

ABSTRACT

The deformation behaviour of solid aluminium alloy (LM6) and silicon carbide metal matrix composite cylinders under axi-symmetric compression over constant aspect ratios using different lubricants were examined. Dry condition and three different lubricants namely MoS_2, graphite and white grease were prepared and cold upset forged. In the light of the previous studies, the calculations were made with the assumption that the curvatures of deformed specimens were in the form of a circular arc. The calculated radius of curvature of the bulge was found under different lubricating conditions. The flow curve of composite was determined by compression tests and data were used in simulation analysis. The FEA simulation was carried out using DEFORM software. Results gained by Finite Element Analysis and by experiment show high degree of similarity, so this way of modeling could be used for even more complex technology of plasticity.

Keywords: *Aluminium Composite, Barreling, Curvature, Finite Element Method, Upset Forging*

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INTRODUCTION

Composite materials offer superior properties to conventional alloys for various applications as they have high stiffness, strength and wear resistance. The development of these materials started with the production of continuous fiber-reinforced composites. The high cost and difficulty of processing these composites restricted their applications and led to the development of discontinuously reinforced composites. Discontinuously reinforced composites have found commercial use in some applications, and among these, particle-reinforced composites are likely to reach the largest commercial application stage with their low cost, ease of fabrication, and improved properties. Particulate metal matrix composites can be produced economically by conventional casting techniques, and they usually posses higher elastic modulus and strength values after reinforcement. As the stiffness and strength are increased, a substantial decrease in ductility is obtained.

Metal forming refers to a group of manufacturing methods by which the given shape of a work piece is converted to another shape without change in the mass or composition of the material. Forming process has become increasingly important in almost all manufacturing industries such as aerospace, steel plants and automobiles applications. The upsetting of solid cylinders is an important metal forming process and an important stage in the forging sequence of many products. Cold forming process minimizes material wastage, improves mechanical properties such as yield strength and hardness and provides very good surface finish (Jolgaf M et al., 2003, Rajiv S 2004 and Victor V 2000). The metal flow is influenced mainly by various parameters like specimen geometry, friction conditions, characteristics of the stock material, thermal conditions existing in the deformation zone, and strain rate. Metal flow influences the quality and the properties of the formed product, the force and energy requirements of the process. The surface roughness of platens determines the friction coefficient and it plays a dominant role in any metal forming operation. It affects the detailed material flow and the deformation characteristics of the work piece, the wear and fatigue failure of the tool, and the mechanical properties of the formed parts. In the cold working of high strength materials a good lubrication or low frictional constraint is always the key to a viable process. Minimizing friction is profitable since it reduces the force and energy required for the prior amount of deformation. A good lubricant or low coefficient of friction at the tool material interface always minimizes the stresses induced in the forming tool and prevent direct tool and work piece contact, which contributes to longer tool life and better quality control. The existence of frictional constraints between the dies and the work-piece leads to barreling of the cylinder and lateral expansion of the specimen is maximum at equatorial section and minimum at end section. However the use of lubricants reduces the degree of bulging and under ideal lubrication bulging can be brought down to zero. The barreling shape of a cylinder under compressing testing has been quantitatively investigated by many researchers. Kulkarni and Kalpakjian (1969) conducted an experimental study of barreling in the upsetting of aluminum billets with and without lubrication. Based on their measurements, they concluded that the profile of the barreled billets can be assumed as an arc of a circle and the shape of the barrel is affected by the initial h_0/d_0 ratio and by the friction conditions. Schey et al (1982) announced that, the shape of the barrel is affected by the geometrical factors such as, the h_0/d_0 ratio, reduction ratio and diameter ratios. They expressed that a power law can represent the barreling profiles of steel and aluminum specimens well for both low and high friction conditions. Gupta and Shah (1985) and Tseng et al. (2001) found out that the barreled shape can be reasonably characterized as the arc of a circle or a circular curvature. Malayappan and Narayanasamy (2000) aimed to find a relationship between the measured radius of curvature of the barrel and new geometrical shape factor based on contact diameters, barrel diameters, initial height and hydrostatic stress while us-