

## SIZE EFFECTS IN THIN SHEET METAL FORMING

C.T. Ann<sup>1</sup>, A.R. Razali<sup>1\*</sup>, N.A.I. Zainudin<sup>1</sup> and Y.W. Leong<sup>1</sup>

<sup>1</sup>Faculty of Mechanical Engineering, Universiti Malaysia Pahang,  
26600 Pekan, Pahang, Malaysia

\*Email: akhtar@ump.edu.my

Phone: +6094246214; Fax: +6094246222

### ABSTRACT

Negligible factors in bulk materials, such as grain-size effects, have proven inappropriate to be neglected for micro-forming processes. Studies had shown that material behaviour varies greatly with the increasing of the scale in the micro-forming world. Therefore, in every micro-forming-related process, especially in micro-stamping, studies and analyses of each material used for the process have to be considered as indispensable in order to be able to understand their behaviour and to be able to correlate their behaviour with the process. Uniaxial tensile-testing experiments have been carried out to determine the strip's properties, behaviour and its correlation with the feeding process in micro-stamping/micro-sheet-forming application. Based on the results of the uniaxial tensile-test experiments conducted, the flow stress was found to decrease with the decrease of the strip thickness and vice versa, due to the size/scale effect. A surface model was used to explain the findings.

**Keywords:** Grain size effect; size effect; thin sheet metal forming; EBSD.

### INTRODUCTION

Desire for better quality of life, good health and high working efficiency has been one of major drives to the innovation of many products hence, new products models were invented, for instance netbook, handheld computers and cars, emerging of new products such as smart mobile phones, MP3 player, ultra-thin flat-screen displays, as well as new medical instruments/implants. Dramatic changes of the global, economic development maps and demand for global market of the said micro-products during last 15 years have significantly influenced how the manufacturing is organized and implemented. It was estimated that micro-products industry through evolvement of miniaturization concept would bring more than 1.5-3.5 billion dollars trade within five years [1-4].

Nevertheless, differ from conventional manufacturing process which is seen more mature and stable, theory of micro-manufacturing process is seen immature enough for industrial transformation or even 24/7 application. A lot of issues have been addressed by researchers around the globe covering the manufacturing methods and processes [5-14]. Not only issues on the machineries and tooling aspect to be tackled and dealt accordingly, challenging issues such as material behaviors also have to be well-versed in order to guarantee total success.