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## ■ Table of contents

Periodical: Materials Science Forum

Volume: Engineering and Innovative Materials V

Papers published in this volume:

<b>Observation of Material Flow in Friction Stir Forming for A5083 Aluminum Alloy Gear-Rack</b> <i>Takahiro Ohashi, Hamed Mofidi Tabatabaei, Tadashi Nishihara</i>	p.113
<b>Evaluation of Friction Properties of Magnesium Alloy during Hot Forging by Ring Compression Test</b> <i>Sueji Hirawatari, Hisaki Watari, Shinichi Nishida, Yuki Sato, Mayumi Suzuki</i>	p.119
<b>Influence of Process Conditions on Spangle Size of 55%Al-Zn Alloy Coated Steel Sheet</b> <i>Tai Xiong Guo, Quan Xu, Chang Rong Ran, Xue Qiang Dong</i>	p.127
<b>The Study of Dendrite Arm Spacing (DAS) on Acoustical of Tin Bronze 20Sn Alloy as Gamelan Bali Materials</b> <i>I. Ketut Gede Sugita, I. Gusti Ngurah Priambadi</i>	p.133
<b>Effect of Secondary Phase Precipitation on Impact Toughness of Duplex Stainless Steel</b> <i>Amit Pawar, Amol Gujar, Niketan Manthani, Vinayak Pawar, Rajkumar Singh</i>	p.138
<b>Investigation on Mode I Propagation Behavior of Fatigue Crack in Precipitation-Hardened Aluminum Alloy with Different Mg Content</b> <i>Samsol Faizal Anis, Motomichi Koyama, Hiroshi Noguchi</i>	p.143
<b>Solidification Analysis in Permanent Mould Casting of Aluminium Alloy LM6 Reinforced Titanium Carbide Particulates Metal Matrix Composites</b> <i>Nanang Fatchurrohman, Shamsuddin Sulaiman</i>	p.148
<b>Investigation of Chip and Surface Roughness when Milling AISI304 Stainless Steel</b> <i>K. Kadirgama, K. Abou-El-Hossein</i>	p.152
<b>Cyclic Oxidation Performance of Si-Aluminide/MCrAlY Coating on Ni-Base GTD-111 Superalloy</b> <i>K. Shirvani, S.V. Miraboutalebi</i>	p.159
<b>Shape Memory Effect in New Ti-Nb-Ta Alloy</b> <i>Alaa Mahmoud Keshitta, Mohamed Abdel Hady Gepreel</i>	p.165

# Investigation of Chip and Surface Roughness when Milling AISI304 Stainless Steel

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**Abstract.** Stainless steel was used for many engineering applications. The optimum parameters need to be identified to save the cutting tool usage and increase productivity. The purpose of this study is to develop the surface roughness mathematical model for AISI 304 stainless steel when milling using TiN (CVD) carbide tool. The milling process was done under various cutting conditions which are cutting speed (1500, 2000 and 2500 rpm), feed rate (0.02, 0.03 and 0.04 mm/tooth) and axial depth (0.1, 0.2 and 0.3 mm). The first order model and quadratic model have been developed using Response Surface Method (RSM) with confidence level 95%. The prediction models were compared with the actual experimental results. It is found that the quadratic model fits the experimental results much better than the linear model. In general, the results obtained from the mathematical models are in good agreement with those obtained from the machining experiments. Besides that, it is shown that the influence of cutting speed and feed rate is much higher on surface roughness compared to depth of cut. The optimum cutting speed, feed rate and axial depth is 2500 rpm, 0.0212 mm/tooth and 0.3 mm respectively. Besides that, continuous chip is produced at cutting speed 2500 rpm meanwhile discontinuous chip is produced at cutting speed 1500 rpm.

## Introduction

Stainless steel AISI 304 is categorized as a very high corrosion resistance metal. This metal has a wide range of excellent mechanical properties which cannot be found in any other alloy. Stainless steel AISI 304 is categorized as austenitic stainless steel. Besides that, stainless steel AISI 304 is a material which is very difficult to machine [1]. Therefore, the machining of stainless steel is accompanied with very high machining cost due to the difficulties. Poor surface integrity and very less tool life are among the common difficulties of these materials. In modern industries, the machining is mainly focused on the surface quality of the product in terms of surface roughness, dimensional tolerance and also high rate of tool life. Surface roughness is one of the complicated parameters in end milling which is process dependent on several factors such as spindle speed, feed rate and depth of cut [1]. Besides that, there are some uncontrolled factors (tool geometry and workpiece material) that also influence the surface roughness on the product. Most of the industries are using 'try and error' method to find the perfect cutting parameters to find the finest surface roughness in their product [2]. However, this is not an efficient method to find the optimum cutting parameters in machining because this process can be very time consuming.

Surface finish influences not only the dimensional accuracy of the machined part, but also the mechanical properties of the part, especially the fatigue strength. The surface finish describes the geometrical features of the surface which in turn determine the fatigue life and corrosion life [3] [4]. Recent investigations performed by Alauddin, El Baradie [5] have revealed that when the cutting speed is increased, productivity can be maximised and, meanwhile, surface quality can be improved. According to Hasegawa, Seireg [6], surface finish can be characterised by various parameters such as average roughness (Ra), smoothing depth (Rp), root mean square (Rq) and maximum peak-to-valley height (Rt). The present study uses average roughness (Ra) for the characterisation of