Study of the correlation between the surface roughness and the characteristic of the acoustic signal from laser texturing process

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Abstract

Growing attention to the laser texturing technology from various industries lately lead to the collective number of studies related to the process optimization. However, in the application related to the process of turning metallic surface into hydrophobic characteristic, process optimization is not the only factor of the quality assurance of the laser-textured surface. The application of real-time monitoring was found to be significant factor to aid in obtaining the desired quality. This paper present the study of the correlation between the surface roughness of the laser-textured surface and the characteristic of sound signal acquired from the process in order to evaluate the feasibility of this signal to monitor the process by a real-time basis. To achieve the goal of the study, laser texturing process had been done on the 316L stainless steel with the different set of peak power and scanning speed. The sound signal was captured between 20 Hz to 20 kHz during the process. The analysis results show that the sound signal recorded the larger amplitude and root means square (RMS) with the increment of laser peak power, and declining scanning speed. This trend show that the RMS of sound increase as the roughness of the textured surface increase. The overall results trend show that the characteristic of sound signal could give the significant information related to the roughness of the textured surface which were produced from different laser parameters. Thus, with further advancement, acoustic method could possibly be used as the real-time monitoring system for a laser texturing process.

1 Introduction

Laser texturing processes are getting popular and increasing demand lately as it offers a solution to wide field of industries. The concept of laser texturing process was applied in the material surface cleaning to improve wettability [1-3], remove corrosion [4-6] , coating [7], as well as bio-substance [8] on many engineering parts or component. On another application, this process was proven to be significant to be use to improve the hydrophobic characteristic of the materials, which simultaneously enhance the corrosion resistance. This had becomes a popular solution for some problem in marine, biomedical, as well as oil and gases industries [9].

As the demand growth, many studies had been done to understand deeper on the effect of laser texturing process to the hydrophobic characteristic of the materials. For instance, Yang et al [10] had investigated the effect of textured pattern to the wettability of the Titanium alloy surface. It was revealed that line, grid, and spot pattern change the hydrophilicity of the titanium surface into super-hydrophobicity. This is due to the change in the surface morphology which affects the adhesion force characteristic. Even though the laser textured pattern was evidently shown to be significant to improve the hydrophobicity of the materials by means of wetting angle measurement, the water-repelling property of the surface does not fully affect the corrosion-resistance behaviour [11]. Mehran Rafieazad et. al [12] revealed that the characteristic of micro-groove formed from laser textured process was the main factor that influenced the corrosion resistant. Meanwhile, other study showed that the scan line separation was the main factor that affects the super-hydrophobicity of the material [13]. Thus, many studies had been done to find the optimized process parameters to achieve the required topographical condition that helps in retaining the hydrophobic condition. In study by Gemini et, al [14], laser parameters such as power and repetition rate were revealed to be influenced the super-hydrophopicity of the 316L stainless steel surface. In their investigation, it was pointed out that power and repetition rate up to 40W and 1Mhz infrared laser was able to produce the good topographic surface to improve hydrophobicity. In spite of determining the optimized process condition, hexadecyltrimethoxysilane duplex treatment was found to be another solution to improve the super-hydrophobicity of the material [15].

Despite focusing on the process optimization, some effort also had been directed to the studies related to the possibility in embedding the online monitoring system to the laser texturing process. Recently, Sascha et al [16] had introduced the diffractive approach in monitoring the surface topography during the laser texturing process. By using the optical approach, the homogeneity of the surface could be evaluated significantly. Even though there were not many studies which