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## Influence of Nano Solid Lubricant Emulsions on Surface Roughness of Mild Steel When Machining on Lathe Machine

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### Abstract

Now a day's turning process is a widely used metal removal process in manufacturing industry that involves generation of high cutting forces and temperature. Lubrication becomes critical to minimize the effect of these forces and temperature on cutting tool and work piece. For this specific study investigation carried out to increase the surface finish of the work piece machined on lathe with addition of nano particles were synthesized by solution combustion process and size was found to be 28 nm from X-Ray Diffraction [XRD]. A thin layer of Al<sub>2</sub>O<sub>3</sub> nano particles on steel can be obtained by various means i.e., liquid and solid process of particle deposition under various machining process. While turning of mild steel rod, three parameters are varied i.e., spindle speed, feed rate and depth of cut. During machining Al<sub>2</sub>O<sub>3</sub> nano particles are sprayed over it. This will lead to form a thin layer over the surface that will change in properties like surface roughness and hardness. Observed better surface roughness for coated material compared to that of base material. Coating thickness also observed at various conditions during machining process.

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*Keywords:* XRD; Al<sub>2</sub>O<sub>3</sub> nano particles; surface roughness; coating thickness

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### 1. Introduction

Now a day's turning process is a widely used metal removal process in manufacturing industry that involves generation of high cutting forces and temperature. Lubrication becomes critical to minimize the effect of these forces and temperature on cutting tool and work piece [1]. A lubricant is the substance which reduces the friction

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between two surfaces which are sliding one over the other. Common solid lubricants are layered compound like graphite, molybdenum disulphide ( $\text{MoS}_2$ ) and tungsten disulphide ( $\text{WS}_2$ ). Their layer slide apart each other to reduce friction, but layered compounds have drawbacks [2]. In this study, we prepared  $\text{Al}_2\text{O}_3$  nano particles by solution combustion process and deposited over a mild steel rod during different machining conditions on lathe machine. The crystal size of  $\text{Al}_2\text{O}_3$  nano particles are tested by using X-ray diffraction (XRD). The surface roughness of the samples is tested by using SJ-310 Portable Surface Roughness Tester. The hardness of the samples is tested by using Rockwell hardness before and after spraying of  $\text{Al}_2\text{O}_3$  nano particles. After spraying of  $\text{Al}_2\text{O}_3$  nano particles on mild steel, the thickness of the coated material is study by using coating thickness gauge. At condition 835 rpm, the hardness decreases as the coating thickness increases because the deposition of  $\text{Al}_2\text{O}_3$  nano particles is more on the specimen.

## 2. Experimental Details

2.1. *Materials Used:* Composition of the base material as shown in Table 1.

Iron	Carbon	Manganese
99.3	0.25	0.45

Table 1: Composition of the Mild steel

- Work material: Mild Steel
- Material size: 50x10mm
- Tool material: High Speed Steel
- Solid lubricant:  $\text{Al}_2\text{O}_3$  nanoparticle size of 28nm

### 2.2 Synthesis of $\text{Al}_2\text{O}_3$ nano particles

Aluminium oxide is prepared by Solution combustion process. Stoichiometric amounts of Aluminium Nitrate and Urea are taken into beaker and stirred it for 30 minutes on a magnetic stirrer and place it on a hot plate ( $\sim 1000^\circ\text{C}$ ).



Heating rapidly the solution containing the redox mixture boils, frothing, smouldering, flaming, fumes and catches fire and burns with an incandescent flame to yield  $\text{Al}_2\text{O}_3$  with evolution of large amount of gases like carbon dioxide, Hydrogen Oxide in the form of flames [3].

2.3 *Parameters Selection in Machining Process:* The following parameters and various conditions are selected during machining process as shown in Table 2.

Speed	Carriage speed	Feed rate
305	22	0.3
500	36	0.5
835	63	0.7

Table 2: Parameters selected in the turning process

### 2.4 Experimental Work

During turning process, a layer of material is removed with respect to the parameters as shown in Table 2. These samples were prepared according to standard dimensions for testing hardness and surface roughness. The  $\text{Al}_2\text{O}_3$  nano particles of size 28 nm are deposited on mild steel during turning process for various conditions.

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