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Testing Tool Material on Scratch Tester

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Abstract: ***In manufacturing industry cutting tools are considered as the backbone of the metal cutting operation. In metal cutting operation there is relative motion between the tool and the workpiece. As the tool material is harder than the workpiece material, there is deformation of the workpiece which acts as a base for the formation of chips. If we observe the process of metal cutting, we can easily find out that there is a considerable amount of heat generated during the machining operation. As there is a point of interface between the tool and the workpiece, there is absorption of generated heat into both the tool as well as work material. Due to the absorption of the heat there is distortion in the tool material. In this research article we have taken the base parameters as speed, load and stroke and the output parameter is taken as the load which breaks the coating of the tool.***
Keywords: tool coating, scratch tester, speed, stroke, coating.

I. INTRODUCTION

In mechanical industry specifically speaking about the metal cutting and fabrication industry the cutting operation is considered as the backbone of the metal cutting. In metal cutting operation the relative motion between the tool and the workpiece plays an important base for the metal removal application. The basic requirement of the metal cutting operation is that the tool material should be harder than the workpiece material so that there will be an ease in cutting of the workpiece. The material removed from the workpiece is called as chip. The nature of the chip formed by the cutting operation depends upon various parameters out of which the nature of the material is one of the important parameter. During the machining operation a considerable wear of the tool takes place. The wearing of the tool decreases the tool life up to a considerable extent. This wearing reduces the tool life which leads to failure of the tool. There are various methods of improving the tool life such as addition of alloying elements in the tool which improves the strength of the tool and increases the tool life up to notable extent. An another approach to improve the life of tool is coating the tool with heat resisting coating that minimizes the amount of absorption of heat in the tool which reduces the chances of thermal distortion in the tool whose overall impact is to improve the tool life. These coatings are applied on the portion of tool which is subjected to the continuos friction zone and the tool workpiece interface zone. These coating acts as a insulating barriers to the heat generated during the machining operation. The maximum amount of heat is taken away with the help of the cutting fluid.

For the conduction of our research work, we have completed a lot of Literature survey to conduct our research work to get an idea about the experimentation work.

II. LITERATURE REVIEW

A. In the scholar article entitled as “The study of the adhesion of a TiN coating on steel and titanium alloy substrates using a multi-mode scratch tester”,published by the author J stellard et al. in the Tribology and international journal 39 (2006). In their research work they prepared a plating or we can say a fine layer of coating of titanium nitride on the tool with the aid of a method known as magnetron sputter ion plating. There research work was subjected to stepwise loading or progressive type of load application and indentation mechanism to check the penetration of the scractch which is being made on the base material or simply the substrate.In their research work they concluded the research work with a notable remark that the developed model of multi scratch can be a future quality tool in the department of quality control.[1]

B. The research article published under the title “ Single-point scratch testing for understanding particle engagement in abrasion of multiphase materials” published by the authors Naveenkumar Rajendhran , Patrick De Baets Shuigen Huang , Jozef Vleugels , Jacob Sukumaran in the journal Elsevier in their research work they mainly focussed on the multi asperity abrasive particles. The materials which are produced by these material were tested by the help of single point scratch tester. In their research work they have taken a reference of the cemented carbide tools for the investigation purpose. At the end of the experimentation work, they concluded the research work with a concluding remark that co efficient of friction shows a significant increase when the load on the surface is increased from 1 N to 5 Newtons.which is occurred due to the microstructural change from the phase started at plastic deformation and ended to the fracture. [2]

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C. In the research article entitled as " Evaluation of measurement uncertainties for a scratching tester" published by Fabio Jose Pinheiro Sousa , Daniel Tridapalli, Milton Pereira , Carlos Alberto Flesch , Orestes Estevam Alarcon in the journal Elsevier Journal 39 (2006). In their research work, they focussed on the analysis of the uncertainties occurring for the scratching tester. They also worked on the calculation of displaced thickness during the scratch test. In their research work they concluded the research work with a notable conclusion that the developed scratch tester is enough capable for the materials having specific removal energy more than 10 gigapascal (10GPa) [3]

D. In the research article published under the title "performance improvement of a zinc plating process using taguchi's methodology" by by p.b.s. reddy and k. nishina in the journal of metal finishing. october 1998. In their research work, they founded a case study and investigated the case study. In the mentioned case study, the parts those are used in the making of type writer were coated with the help of zinc to avoid the corrosion. But after the coating at the inspection stage, it was found that the coating thickness was not uniform. This problem was analysed by the taguchi methodology and the data was collected.[4]

III.EXPERIMENTAL SETUP

The machine on which the experimentation is conducted is as shown below.



FIG.1. MECHANICAL TESTER

Apart from the mechanical tester the technical specifications for the tester are as shown below in the following tables

Table 1. Properties of Zinc Plating

Parameter	Observed Value
Colour	Yellow, light blue, black, green
Load Bearing capacity	2N-15N
Minimum thickness	(0.2 µm -15 µm)
density of Zinc plating	0.45 oz/ft2/mi (coating weight/ thickness)
Corrosion protective plating on MS steel, Iron.	

The technical specifications of mechanical scratch tester is as shown in table 2.

Table 2. Technical specification of the mechanical tester

Parameter	Specification
Stroke	0 to 50mm
Normal load	2 – 20 & 20 - 200 N
Tractional force	2 – 20 & 20 - 200 N
Loading Rate	2 - 20 N/mm
Scratching speed	0.1 to 5 mm/sec
Pitch	0 to 5mm
Load applied	Either in Variable/ramp load
Sample size	60 x 60 x 10mm
Sample holding	Mechanical vice
Indenter	Diamond indenter Rockwell C, with tip radius R200microns rockwell hardness tester indenter
Image acquisition system	For image viewing & image capture, auto exposure , brightness control , USB protocol, with zoom in & out function , USB protocol with software SCAR VIEW for measurement

The parameters are selected for the conduction of experimentation according to the taguchi orthogonal array.

Table 3. parameters for the orthogonal array

Parameters	Unit	1	2	3	4	5
Load	Newton	2	4	6	8	10
Speed	mm/sec	1	2	3	4	5
Stroke	mm	1.5	1.9	2.3	2.7	3.1

The experiments are conducted and the trials were recorded according to the array given by taguchi's design of Experiment methodology.

The graphs obtained by the taguchi method of experiment is as follows:

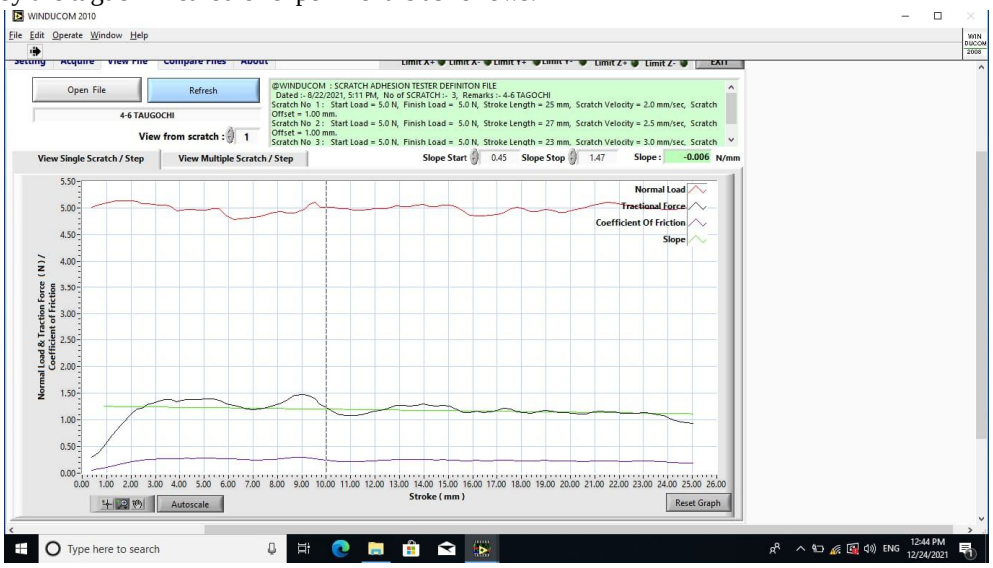


Fig.2. Graph of Normal force vs stroke



Fig.3. Graph of Normal force vs stroke

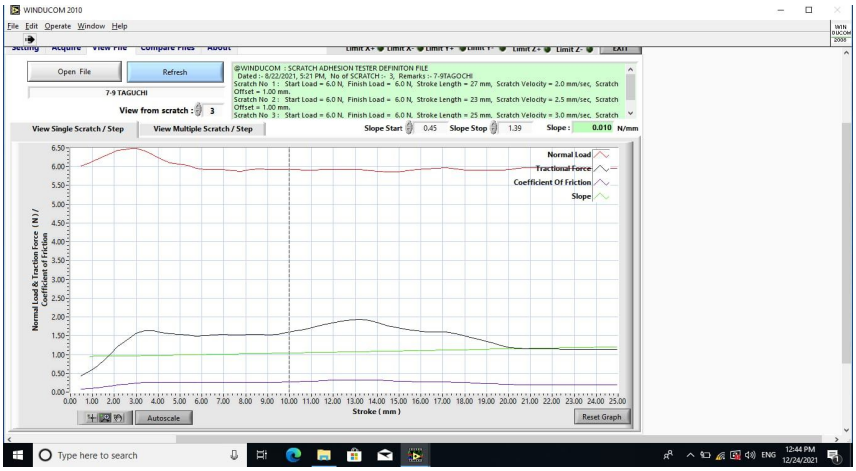


Fig.4. Graph of Normal force vs stroke

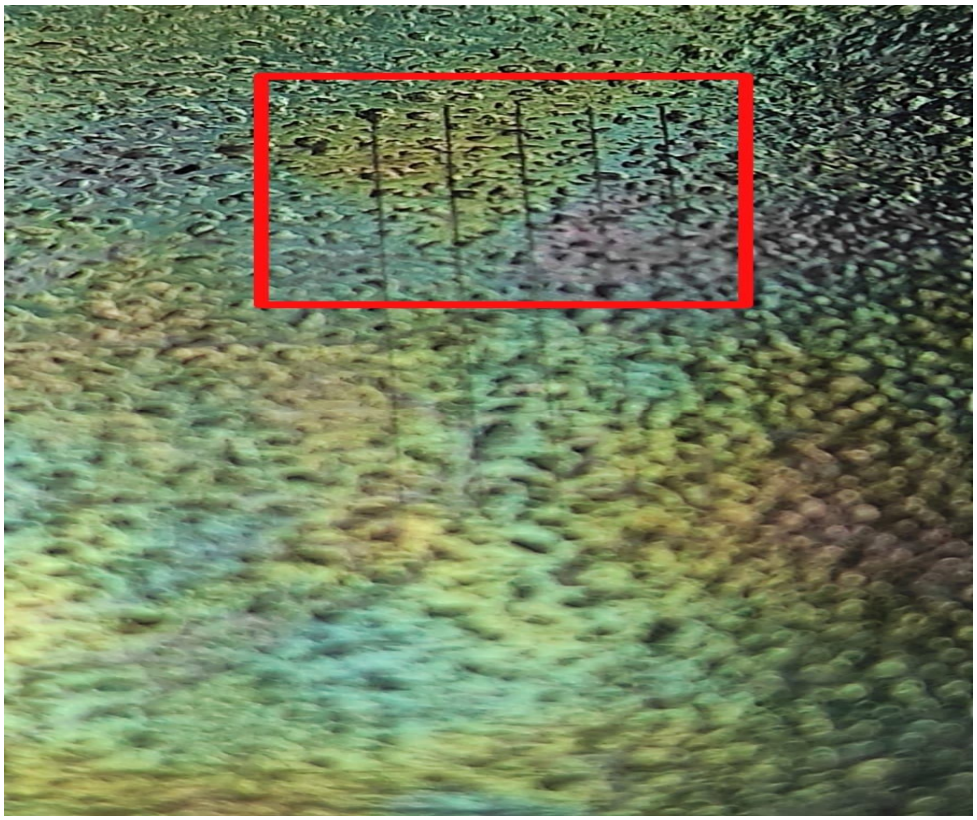


Fig.5.Scratch generated on the specimen by the mechanical tester

IV. CONCLUSION

In the above experimental work, we have taken the level of loads as 4N, 5N, 6N.the graphs obtained from the respective loads are mentioned above. In the fig 2 for the load of 5 N and stroke length as 23cm 25 cm & 27 cm, the graph for the tractive force or normal force versus the stroke is plotted, from the fig 2, it has been observed that the normal force fluctuations for the given stroke is less as compared to the normal force or tractive force exerted for the stroke length. It is also observed that there is little fluctuation in the co efficient of friction for the given stroke length.

Similarly, for the fig 4 for the load of 6 N and three stroke lengths as 23cm, 25cm, & 27 cm, the coefficient of friction has the least fluctuations in the current scenario.

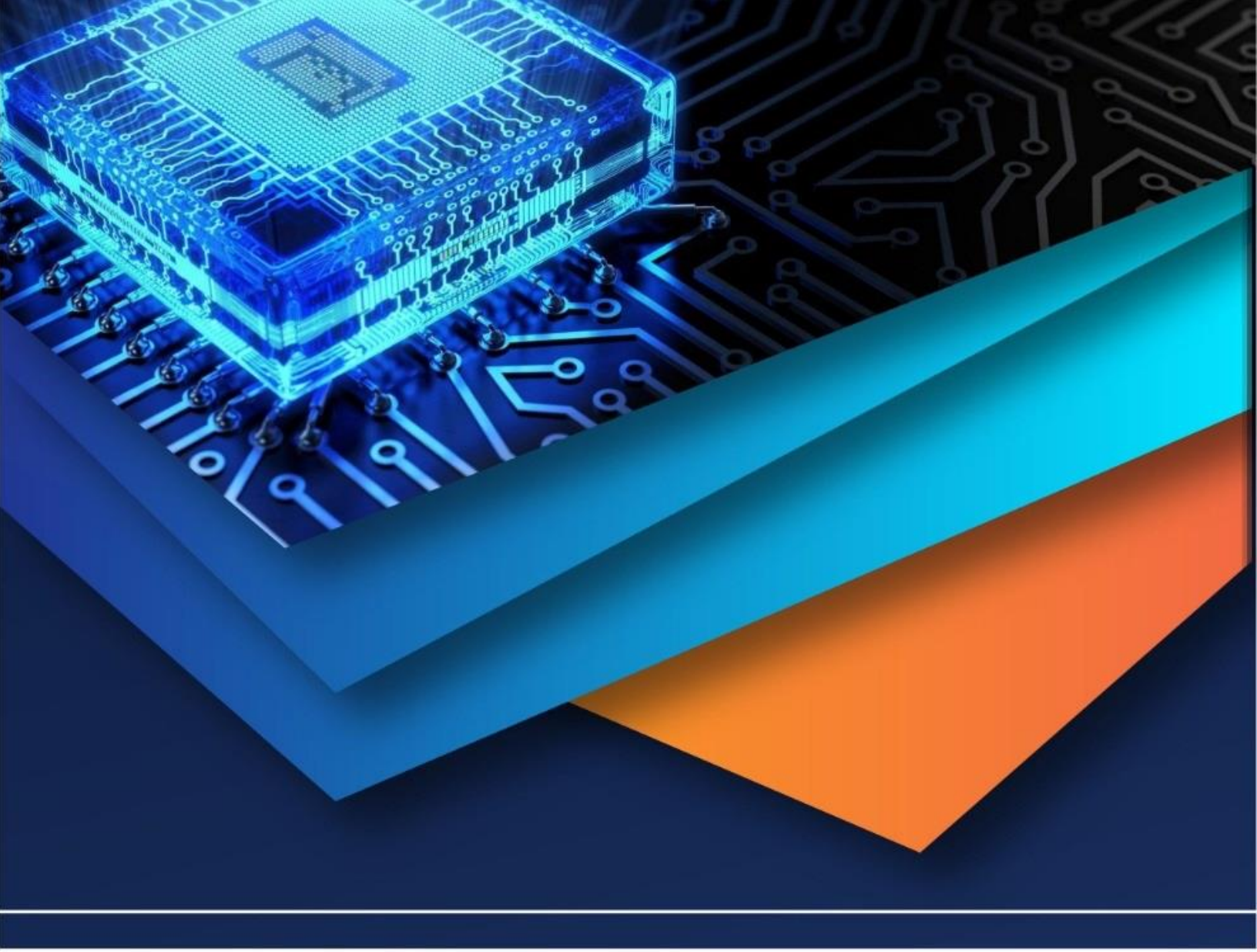
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