Investigation of effectiveness of combined turning and burnishing operations performed on lathe machine on an aluminium alloy for the modification of surface texture

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Abstract - ***Burnishing is a cold working process carried out on materials that employs plastic deformation of a surface layers in order to improve surface characteristics such as surface finish or reduction in surface roughness, increase in micro hardness, wear resistance of the workpiece. Machined surfaces by conventional manufacturing processes such as turning have inherent irregularities and defects Like tool marks and scratches that cause energy dissipation (friction) and surface damage (wear). Burnishing is a kind of chip-less processing which improves the surface integrity of machined components. A new burnishing tool is introduced in this investigation which enables double ball burnishing process with turning in one setting without releasing the workpiece. Result of combined process showed significant effectiveness of the newly developed burnishing tool, for the aluminium alloys in this investigation. The results of combined turning and double ball burnishing were better than that of performing individually.***

Key Words: *Ball burnishing, turning surface roughness, microhardness*

1. INTRODUCTION

The surface finish quality and surface hardness of the machined components are essential Requirements due to its direct effects on the function of the components. Finishing processes such as hard cutting, grinding, polishing, and lapping are commonly used to improve the surfaceFinish of the machined components. Some researchers have been carried out recently to improve surface characteristics by using ball burnishing process. Ball burnishing process, as shown in fig. 1, which is one of the surface finishing processes that results in a plastic deformation on the workpiece surface by using a ball or a roller .Plastic flow of the original asperities occurs when the yield point of the work piece material is exceeded consequently the asperities will be flattened. The improvement of the surface roughness through the burnishing process generally ranged between 40% and 90%

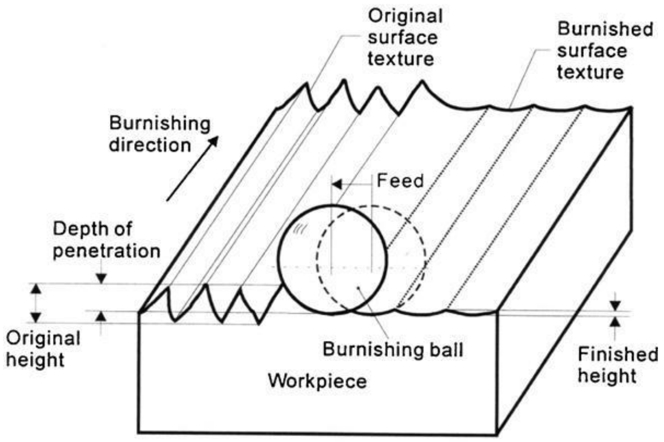

Fig- 1: Schematic representation of the ball burnishing process

The motive of this research work is mainly to introduce a new double ball burnishing tool which enables both turning and double ball burnishing process on a conventional lathe in one setting without releasing the work piece. Effect of various burnishing parameters, on final surface texturewere studied and demonstrated.

2. Experimental Investigation

As mentioned, the main objective of this work is to examine the use of a newly developed ball burnishing tool which will be used to improve surface characteristic playing an important role on the required tolerance and fit especially during assembly of parts. The effects of burnishing parameters namely burnishing speed, feed, ball materials, and no of passes on surface roughness and hardness are comprehensively studied through this work. In this current research paper, an effort is being made to understand the mechanism of improvement in the surface finish and surface hardness of burnished surfaces along with the influence of the process parameters on aluminum alloys which is commonly used in shafts, automobiles and aviation parts.

3. Setup for the Experimentation

The work piece to be finished and burnished is clamped by the three-jaw chuck of the lathe and if required it is guided from other side by the lathe tailstock. The burnishing process was applied immediately after turning process is completed without releasing the work piece from the lathe chuck to keep the same turning alignment.
As the aim of this investigation was to study the effect of the new turning and burnishing tool upon final surface texture (roughness and surface hardness), and to Study the effect of burnishing parameters namely burnishing feed, burnishing speed, and no of passes upon final surface texture (roughness and hardness).

Table-1: Burnishing parameters

Burnishing feed(f) µm/rev.	30, 40, 50
Burnishing speed rpm.	50, 60, 70,
No.of passes	1, 2, 3
Depth of penetration	3.0 mm

In this work, produced surface hardness were carefully measured after burnishing process. The experimentation was performed on work piece material .combined process of burnishing where turning and burnishing carried out in one setting without releasing the workpiece.
The combined turning and two-ball burnishing tool is shown in figure 2. The balls are located inside an interchangeable adapter, are made of Tungsten carbide and have a diameter of 10 mm each. The balls are free to rotate with the movement of the work piece due to frictional engagement between their surfaces. When balls are pressed against the surface of metallic Specimen, the adaptor compresses pre-calibrated springs. The springs are used to reduce the possible sticking effect of the balls.
This tool includes two-ball bearings and two flat-ended springs having stiffness 18.00N/mm. The combined turning and two-ball burnishing tool is designed in a simple manner so that it can be mounted easily on lathe machine.

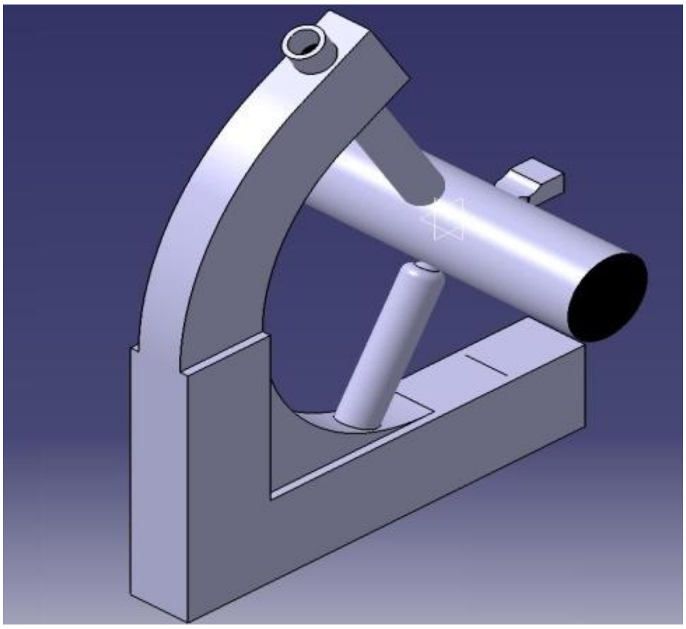

Fig-2: burnishing tool

4. Workpiece material

The material used in this study is aluminium alloys 6061. This material was selected due to its Importance in industry. These materials have wide industrial application because of their specialized mechanical properties. The chemical composition is 96% Al, 0.04% Cr and 0.155% Cu, and mechanical properties are σ_u= 310 N/mm^2, and BHN= 95.
The test specimen configuration is 180 mm working length and 32 mm diameter whereas burnishing is performed on 30 mm diameter.

5. Results and discussion of burnishing parameters on surface hardness

Effect of feed rate: As mentioned before three burnishing feeds were selected for this test. The effect of feed rate (f) was studied with various burnishing speed of 50 rpm, 60 rpm, 70 rpm and for different number of passes to study the interaction between the two parameters. The relations are plotted as shown in Chart 1, 2, 3
It is observed from the figure that surface hardness increases with increase in tool feed. Also it is observed that surface hardness increases for increase in speed for same set of tool feed.

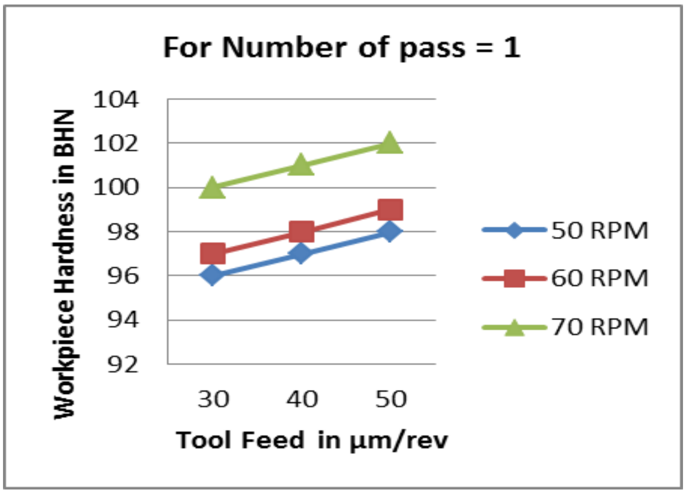

Chart-1: Effect of burnishing feed on workpiece hardness for various speed and number of passes = 1

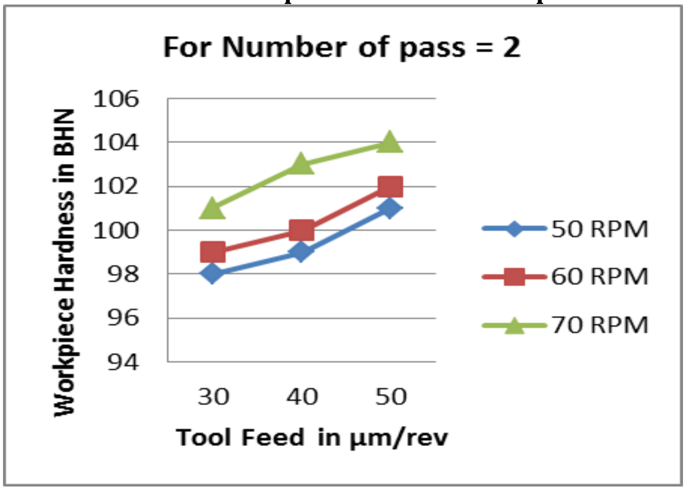

Chart-2: Effect of burnishing feed on workpiece hardness for various speed and number of passes = 2

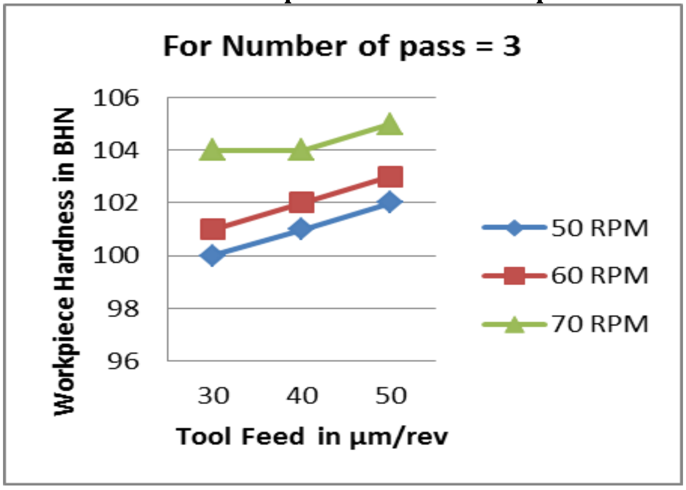

Chart-3: Effect of burnishing feed on workpiece hardness for various speed and number of passes = 3

Effect of burnishing speed: As mentioned before three burnishing feeds were selected for this test. The effect of Workpiece speed was studied with various tool feed of 30 µm/rev, 40 µm/rev, 50 µm/rev and for different number of passes to study the interaction between the two parameters. The relations are plotted as shown in Chart 4, 5, 6.

It is observed from the figure that surface hardness increases with increase in Workpiece speed. Also it is observed that surface hardness increases for increase in tool feed for same set of workpiece speed.

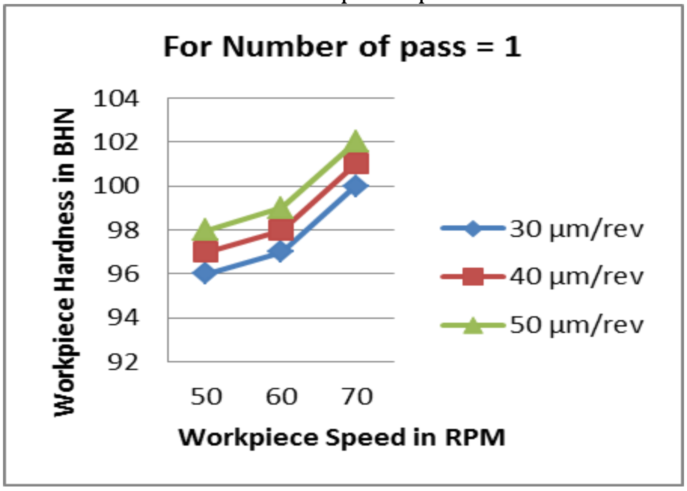

Chart-4: Effect of workpiece speed on workpiece hardness for various tool feed and number of passes=1

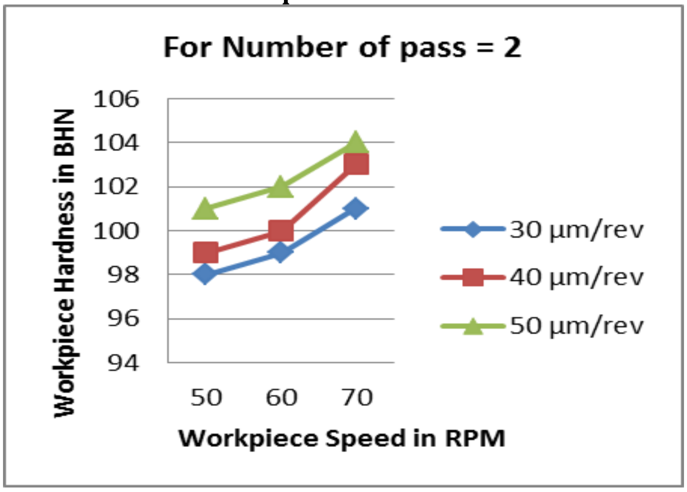

Chart-5: Effect of workpiece speed on workpiece hardness for various tool feed and number of passes=2

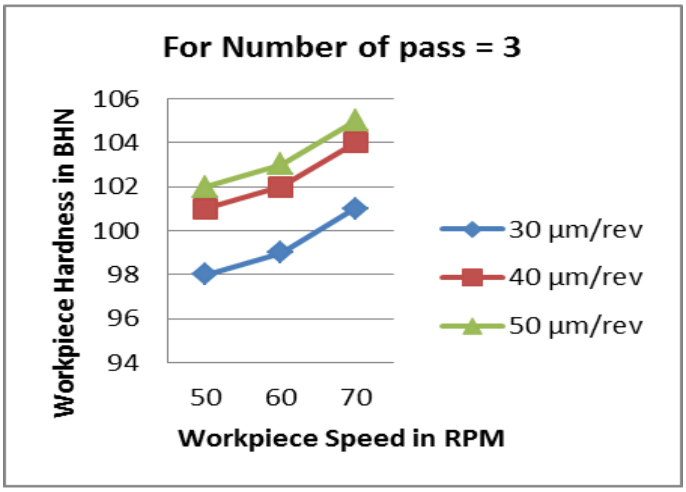

Chart-6: Effect of workpiece speed on workpiece hardness for various tool feed and number of passes=3

Effect of number of passes: Three numbers of passes were selected for this test. The effect of number of passes was studied with various tool feed of 30 µm/rev, 40 µm/rev, 50 µm/rev and for different workpiece speed to study the interaction between the two parameters. The relations are plotted as shown in Chart 7, 8, 9.

It is observed from the figure that surface hardness increases with increase in number of passes. Also it is observed that surface hardness increases for increase in tool feed for same set of number of passes.

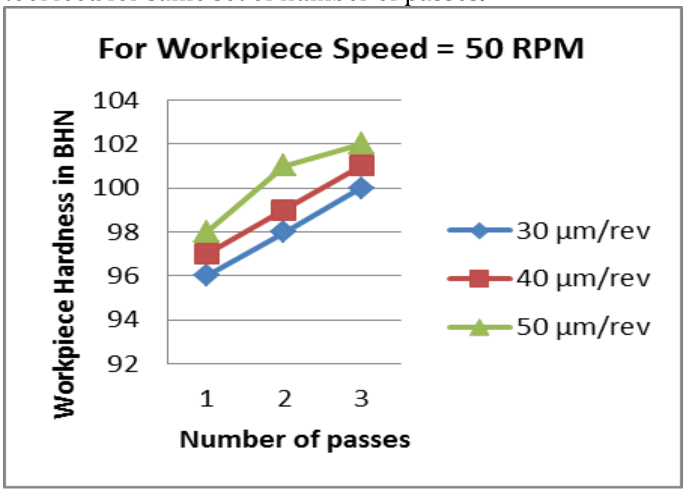

Chart-7: Effect of Number of passes on workpiece hardness for workpiece speed = 50 RPM

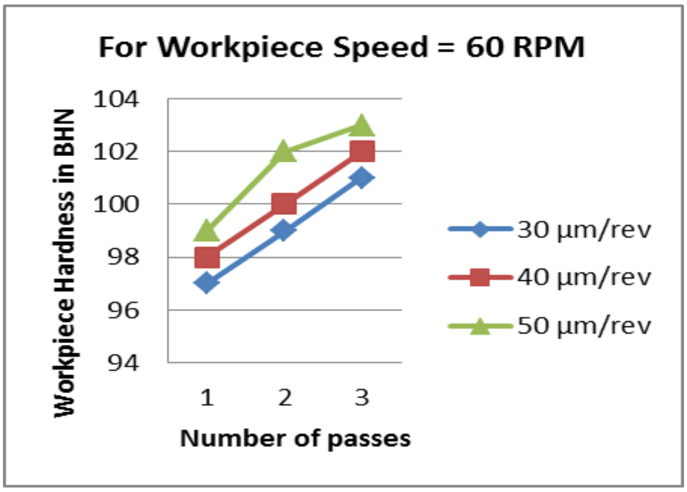

Chart-8: Effect of Number of passes on workpiece hardness for workpiece speed = 60 RPM

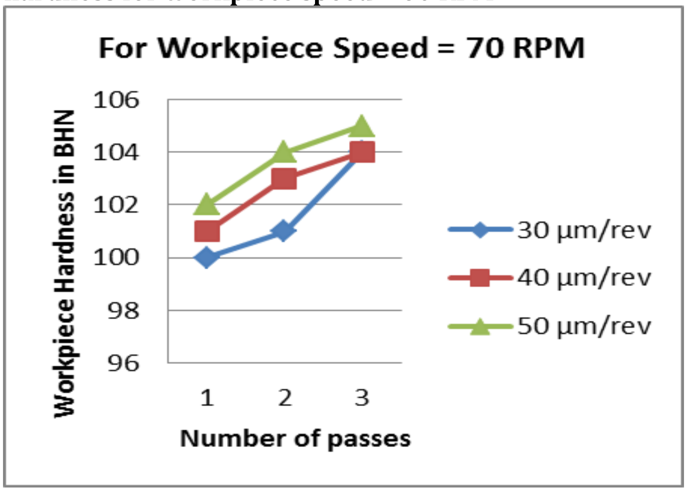

Chart-9: Effect of Number of passes on workpiece hardness for workpiece speed = 70 RPM

6. Conclusion

A method of combined turning and burnishing is introduced in this investigation with new double ball burnishing tool which enables double ball burnishing process with turning in one setting without releasing the workpiece. Effect of burnishing parameters on final surface texture (surface hardness) was demonstrated.

•Burnishing results showed significant effectiveness of the burnishing tool in the process. The surface hardness of the turned test specimens were improved by burnishing. But when the burnishing process is carried out in setting without releasing the workpiece provides superior results of surface finish.

•As the no of passes increase surface hardness increases. This is because of the continuous pressure of the ball of the burnishing tool on the workpiece. Surface hardness gets better and better with increase in no of passes.

•Thus it is conclude that the combined turning and burnishing process gives better surface hardness and enhances surface texture characteristics.

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