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Ultrasonic Machining Process

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Abstract - *Non-traditional manufacturing processes is defined as a group of processes that remove excess material by various techniques involving mechanical, thermal, electrical or chemical or combination of these energies without the use of any sharp edges cutting tools. Precision abrasive processes are commonly employed to machine glasses, single crystals and ceramic materials for various industrial application. Manufacturing technologies are well developed for materials like metals and their alloys, considerable problems still exist in the fabrication of hard and brittle materials including ceramics and glass. Ultrasonic machining (USM) using loose abrasive particles suspended in a liquid slurry for material removal is considered an effective method for manufacturing. Any material can be machined, any complicated shapes can be produced with the help of ultrasonic machining process and high accuracy can be Achieved.*

Key Words**:** *Non traditional machining, Ultrasonic machining process, Material removal mechanisms.*

1. INTRODUCTION

Manufacturing industries like aviation, nuclear, missile, tool and die making now use newly developed hard and difficult to machine material demanding high precision and surface finish. Difficulty in simultaneously achieving high degree of precision and the surface finish in the traditional methods machining. Ultrasonic machining (USM), using shaped tools, high-frequency mechanical motion, and abrasive slurry is effective for materials of extreme hardness or brittleness. Non-traditional machining techniques such as electric discharge machining and laser beam machining have been proposed to machine hard and brittle materials. These processes have prominent limitations that the machined surfaces are always subjected to heat induced damages like recast layer and thermal stress. Ultrasonic machining (USM) is another alternative method for manufacturing both conductive and nonconductive hard and brittle materials. It is known as a total mechanical process without suffering from heat or chemical effects. This article presents that USM can provide greater output and effectiveness.

1.1 Background

Unlike other non-conventional machining methods such as laser beam and electrical discharge machining, USM does not thermally damage the workpiece. Traditional ceramics and glasses are extensively used to manufacture many products currently used in daily life. Ceramics and single crystals are extensively used in the production of electric, electronic, magnetic and optical components for high performance systems such as transducers, actuators and sensors.

This process is characterized by low material removal rate (MRR) and almost no surface damage to the work material machined. It can be used for hard and brittle material with low ductility and high hardness into complex shapes with good accuracy and reasonable surface finish. The process is particularly suitable to machine holes with a curved axis of any shape on the workpiece material.

1.2 Motivation

The main reason for using non-traditional machining process are to machine high strength alloys, to produce complex surface, to achieve high accuracy and surface finish, to obtain deep hole with small hole diameter.

Forming and sintering processes of ceramic powders do not necessarily give the high dimensional accuracy and the good surface quality required for functional and structural components. Thus precision machining technologies have been developed for the manufacture. Ultrasonic machining(USM) used extensively in manufacturing hard and brittle materials that are difficult to cut by other conventional methods. The actual cutting is performed by abrasive particles suspended in a fluid.

2. PROCESS OF MANUFACTURING

USM is mechanical material removal process. It is consist of power supply, piezoelectric transducer, abrasive slurry, tool, tool holder, workpiece, horn and fixture. High-frequency electrical energy can be converted into mechanical vibrations with resonant fre-quency via the transducer. The excited vibration is subsequently transmitted through an energy-focusing horn to amplify the vibration amplitude and finally delivered to the tool. Thus, the tool which locates directly above the workpiece can vibrate along its longitudinal axis with a desired high amplitude. A slurry comprising hard abrasive particles in water or oil is provided constantly into the machining area. During the fabrication of hard and brittle materials, a large number of tiny fractures occur on the work surface and lead

to the material removal. The shaped tool under the actions of mechanical vibrations causes the abrasive particles dipped in slurry to be hammered on the stationary workpiece.

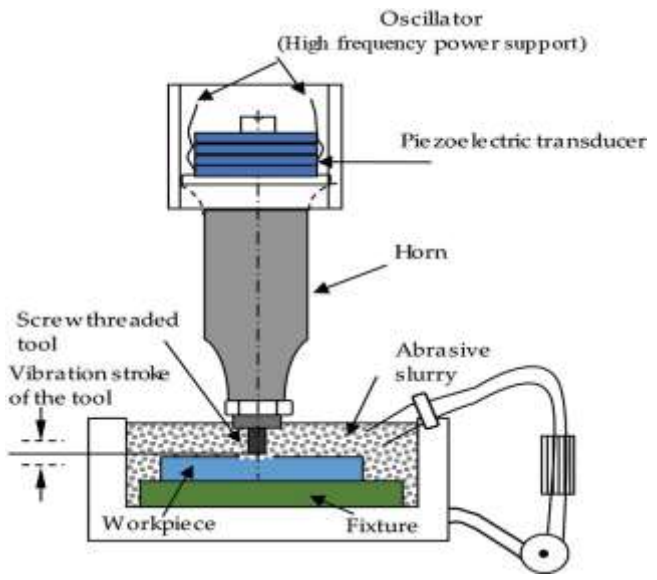

Fig -1: Ultrasonic machining process

2.1 process parameters and capabilities

In this process amplitude of vibrations 15 to 50 micrometer, Frequency of vibrations is 19 to 25 kilohertz, abrasive size and abrasive material is al2o3, SiC, diamond. USM can machine work piece harder than 40HRC to 60HRC like carbides, ceramics, glass that cannot be machined by traditional methods. Process tolerance range is 7 to 25 microns.we can obtain holes upto 76 microns. Material removal rate is 0.025 to 25 mm/min.

2.2 Advantage of USM

- USM does not produce thermal, electrical and chemical abnormal surface
- Non thermal
- Non chemical
- USM process is used for drilling both circular and non-circular holes in very hard materials like carbide, ceramics

2.3 Application

- Glass, Ceramic, carbides, diamond, tungsten land semi-precious stones can be machined.
- USM can make round and non round shapes in hard and brittle materials.
- USM is used for grinding Quartz, Glass, Ceramic.
- USM can be used to cut industrial diamonds.

3. CONCLUSION

Ultrasonic machining process (USM) is purely depends on the work material properties mainly hardness, fracture toughness, tool properties, abrasive properties. Ultrasonic machining (USM) is of particularly interest for the machining of conductive, non-conductive, brittle materials such as engineering ceramics. The machining of materials such as Glass, Super alloys, Ceramics, tungsten carbide etc. to their final dimension by traditional methods is extremely difficult, tough and generally not possible. To overcome such kind of problems USM can be utilized.

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