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Changing the physical properties of germanium alloy after ultrasonic machining

Tursunbaev Sarvar, Abdurakhmonov Khusniddin,Sultonov Khasan,Kariev Saidislom,Usmanov Ravshan

Senior teacher of department Mechanical Engineering,Tashkent State Technical University named after Islam Karimov;
Head of department Mechanical Engineering,Tashkent State Technical University named after Islam Karimov;
Master student, Tashkent State Technical University named after Islam Karimov.
Master student, Tashkent State Technical University named after Islam Karimov.
Master student, Tashkent State Technical University named after Islam Karimov.

ABSTRACT: In this article, it is introduced and reviewed machining of Germanium alloy by the help of ultrasonic vibration technology .Information is given on the ongoing research work on the use of Ge and their processing on metal cutting machines. The article also gives data on the results of research work of researchers.

KEYWORDS: ultrasonic, elastic deformation, Bauschinger effect, viscoelastic deformation, Germanium.

I. INTRODUCTION

Ultrasonic vibration-assisted (UVA) machining is a process which makes use of a micro scale high frequency vibration applied to a cutting tool to improve the material removal effectiveness. Its principle is to make the tool work piece interaction a microscopically nonmonotonic process to facilitate chip separation and to reduce machining forces. It can also reduce the deformation zone in a work piece under machining thereby improving the surface integrity of a component machined. There are several types of UVA machining processes, differentiated by the directions of the vibrations introduced relative to the cutting direction. Applications of UVA machining to a wide range of work piece materials have shown that the process can considerably improve machining performance. Ultrasonic vibration-assisted cutting is superior to produce ultra-precision and sophisticated structures in the feature size of several to hundreds of micrometers practically. It also has many advantages of high geometrical accuracy, good surface quality and high machining efficiency. Diamond cutting allows a high degree of freedom for the structural design as compared with other methods, and thus it has been widely used especially for plasitic molding applications of a variety of optical elements. Combining with mass production process such as injectionlding and compression molding, diamond cutting becomes available for manufacturing of high-quality and low-cost consumer products, and hence, quickly popularizes among the related industries. Ultraprecision diamond cutting is usually applied to the fabrication of precision parts on plasitic materials, such as the soft metals including oxygen-free copper, brass, aluminum alloy, polymeric material such as PMMA, electroless nickel-phosphorus plating , and so on. Recently, ultra-precision dies and molds made of difficult-to-cut materials, i.e., hardened steel and tungsten carbide, are greatly required for the mass production of functional elements with micro/ nano structures, especially in optical industry. However, the conventional diamond cutting is not applicable directly to steel materials due to the extremely chemical tool wear .

II.MATERIALS AND METHODS

The important manifestations of incomplete elasticity of materials relates to the elastic after effect. It indicates that not all-reversible deformation of the metal is purely elastic. The effect of an elastic after-effect - a part of the elastic deformation grows instantly, and the rest develops overtime. Elastic after effect - the phenomenon of relaxation, consisting in the change with time of the deformed state of a solid body at a coastant stressed state. The elastic after effect is characterized by the unambiguity of the equilibrium conditions (complete recoverability) between stress and

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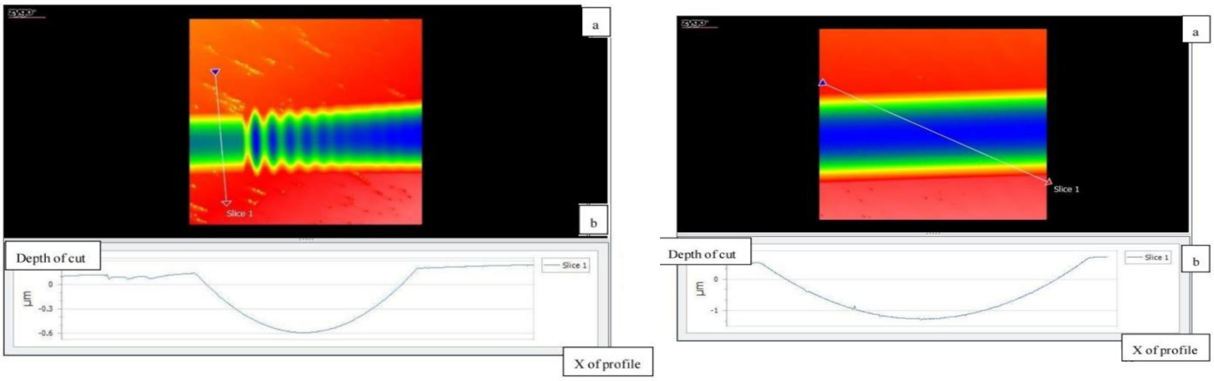
strain, the equilibrium value of which is reached after a sufficient time has passed. The duration of the change — the relaxation time — depends on the mode and temperature of the deformation, as well as on the

prehistory and the properties of the solid. The Bauschinger effect is to reduce the resistance to plastic deformation when the sample is reloaded. After intermediate loading with the opposite sign. The Bauschinger effect reduces the flow effect. The cause of the effect is the instability of the structural state under alternating loading. From manufacturing practice it is known that the diameter of the materials after turning is somewhat larger than the diameter in the unloaded condition when the carriage is supplied due to the phenomenon of elastic after effect of materials. Combinations of technological factors of the turning process, the magnitude of the elastic after effect of the metal is comparable to the tolerance field for qualifications of accuracy. In industrial conditions, the task of ensuring a given qualification of accuracy is complicated by the fact that the scientific and technical literature still lacks the necessary generalizations of materials and methods on the question of quantifying the magnitude of the elastic after effect of a metal depending on the technological factors of the germanium turning process. This makes it difficult to design and implement modes of production of parts from Shelman with high dimensional accuracy. To study the effect of the nature and magnitude of the resulting stresses on the elastic after effect of the material, a study was conducted with the output of results below.



I *II*

Figure 1.I- Zero-level cutting =750nm; II-Cutting with depth of cut= 1.9µт;

a- photo; b-profil.

We made number of grooves, determine elastic compression with using of microscopy. Then made equitation for future calculation of accuracy. Comparing it with knowledge about conventional cutting, we obtained value of elastic deformation of Ge in a process of ultrasonic vibration cutting.

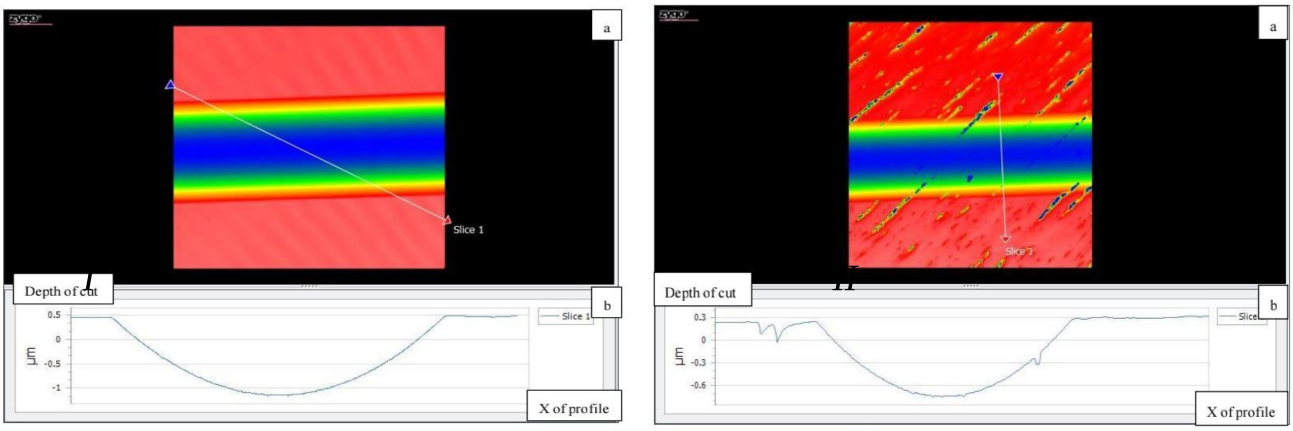


Figure 2.I- Cutting with depth of cut= 1.7µт; II-Cutting with depth of cut= 1.25µт;

a- photo; b-profile.

Approximately elastic deformation of Ge with cutting depth more than 1 µm is 250nm.

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As we can see elastic deformation of Ge in a process of cutting with using of ultrasonic vibration is equal with the other ones, where they don't use.

The phenomenon of reducing strain in time after removal of the load is called reverse creep. The phenomenon of the inverse creep of a number of materials, in particular metals, has been studied relatively little, and therefore, in the calculation as of structural elements for creep is not taken into account.

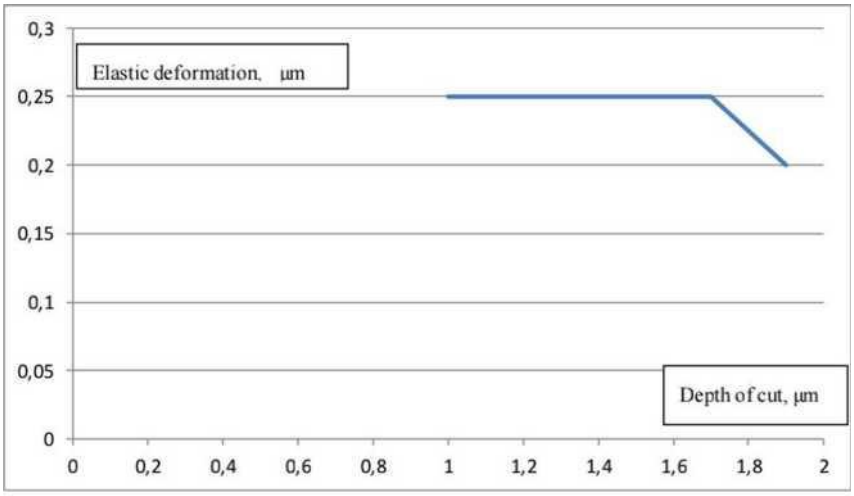

Figure 3. Graph of elastic deformation with a different depth of cut.

Note that reverse creep along with elastic unloading is called recovery. The reverse creep of polymers is directly related to the visco elastic component of total deformation. Recoverability after creep is the simplest additional experiment. In another case, the rapid unloading of the machine by the mechanism may lead to some loading by the voltage of another sign, which is also unacceptable. In turn, the complete restoration of deformations in such an experiment provides an invaluable check on the correctness of equipment installation. It is recommended that the creep test be carried out together with the recovery without interruption. You should prepare for a series of tests and then make the necessary selection of results based on them. The isochronous stress-strain ratio can be obtained directly in an experiment on one sample, if the time interval is small, and the stresses do not cause significant viscoplastic deformations.

III.CONCLUSIONS

After carrying out number of the experiments of machining of hard alloy, we received some important data. This data help sscientists and manufacturers make their production and researches. Moreover, this information let us deeply understand processes which take a place during machining of hard and brittle materials. Data consist of the following results.

1. Total depth of cut was increased more than 4times, while using of UVC. According to this table parameters, corresponding maximum productivity with using of UVA cutting are nextv=200m/mia h=l.8 QM
2. Elastic deformation of hard alloy in a process of cutting with using of ultrasonic vibration is equal with the other ones, where they don't use.
3. Surface, produced with a sing of UVA, good enough for machining Fresnel lens. Roughness criteria for this type of surfaces limited by Sa=0.3 мm. So, take into the consideration conventional cutting roughness, UVA cutting roughness even better.

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