ISSN 1392 - 1207. MECHANIKA. 2005. Nr.6(56)

Improvement of mechanical characteristics of a cutting edge of the blade instrument by means of electromechanical processing

V.P. Bagmutov, S.N. Parshev, N.Y. Polozenko
Volgograd State Technical University, Lenin avenue, 28, 400131 Volgograd, Russia, E-mail: sopromat@vstu.ru

1. Introduction

One of the ways of cutting properties improvement of the blade instrument widely used in tanning, fur, paper-cellulose, textile etc. industries is the application of high-energy surface hardening methods of the working profile of cutting edges of the instrument, such, as laser and plasma hardening, ionic implantation and etc.

But, the usage of these methods is rather restricted mainly, because of high cost of inventory, complexity of master schedules. The principal methods of hardening of the blade instrument remain volumetric quenching and HF quenching, which bring about a warping of the working profile of the instrument, origin of thermal efforts etc. deficiencies.

Electromechanical handling (EMH) is widely used for surface hardening of steel details working as relative frame conjugations under abrasion and wear. Thus the endurance of details increases 6-14 times, depending on service conditions [1].

The advantages of EMH are as follows: simplicity of the processing equipment; usage as a radiant of high concentrated energy - electrical current, high efficiency of the process, opportunity of targeted regulation over a wide range of hardening parameters [2].

It allows to consider the application of EMH for forming cutting edges of the blade instrument manufactured of tool house simple steels to be effective.

Forming a cutting edge of the blade instrument it is necessary to get a width of a white stratum, of about one and more mm in conditions of the restricted heat sink, because of usually small mass of the hardened work piece. It causes the development of new flow diagrams of EMH and choice problems considering rational technological conditions of hardening [3].

2. Testing procedures

This article presents the results of influence explorations of the base technological conditions EMH (current density and speed of handling) on the properties of surface and near-surface stratums of steels У8А and У10.

On Fig. 1 the flow diagram EMH of flat tools is presented. The flat tool *1* is anchored on heat-removing sink *2*, installed on the table of a milling machine. The presence of the heat-removing sink made of tough-pitch copper, is a distinctive feature of the offered flow diagram permitting to gain a white stratum on articles of small width (3 - 5 mm) [4]. The warping electrode - instrument *3* is fixed in the dynamometer cage on the spindle of a milling machine captured from the possible gyration and with calculated warping gain (about 0.5 - 1.2 kN) nestles on the surface workpiece. The choice of warping gain is performed in correspondence with the guidelines explained in operation [5].

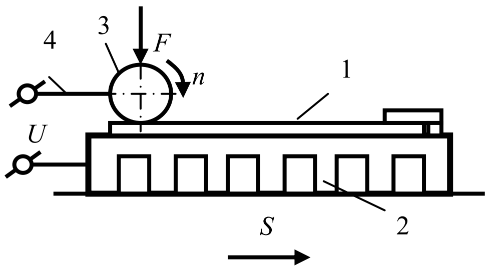

Fig. 1 Flow diagram EMH of flat tools

The headway of feeding *S* is imported to the workpiece, thus the warping roller freely rotates with frequency *n*. The instrument and workpiece are under the voltage regulated within 0 - 7 V. Thus through the contact electrode - instrument flows the current of about 1000 - 2000 A/mm^2 density. For the improvement hardened surface quality and warping instrument stability on the workpiece surface the lubrication is plotted before handling.

As usually for EMH the white stratum track of the width "h_{max}" and length "a", in the shape of a segment (Fig. 2) is obtained on the workpiece.

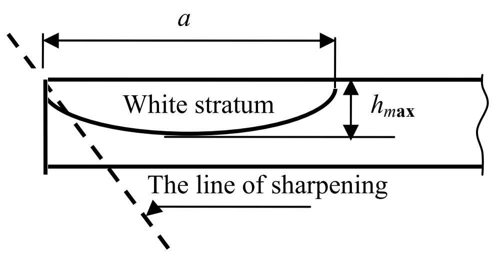

Fig. 2 Tool sharpening scheme

Thus, for the development of forming technique of a cutting edge blade of EMH instrument it is necessary to examine the influence of current density and speed of handling on surface microhardness and white stratum width with the purpose of working intervals entering for the indicated conditions.

3. Estimation of optimal operation mode

On Fig. 3 the influence of current density, and on Fig. 4 the influences of handling speed on the width of white stratum forming and its microhardness for flat tools (material - steel У8А) are shown. As it can be seen on the graphs, at current densities less than 200 A/mm^2 white stratum is not formed. Further current density increase leads to the white stratum width increase up to maxima at practically invariable microhardness. Subsequently a sharp unhardening of the white stratum takes place.

Thus, for securing of the maximal width of the formed white stratum at surface microhardness, close to maximal, the current density should be 1450 - 1950 A/mm^2.

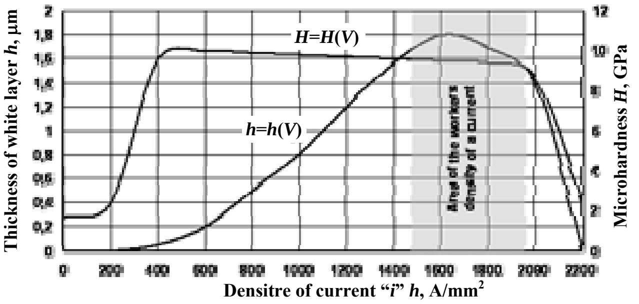

Fig. 3 Influence of current density at EMH on microhardness and width of the white stratum.

At very low (up to 4 mm/s) handling speeds there is no formation of the white stratum, that is explained by poor heat removal from the surface. When the speed of about 6 - 6.5 mm/s is reached the discrete forming of the white stratum, appears that is characterized by step like surface microhardness increase, which at further magnification of speed practically does not vary, while the width of hardened stratum is diminished. In relation with abovestated, for steady forming of a white stratum with the width close to maximal, handling speed should be about 6 - 7 mm/s.

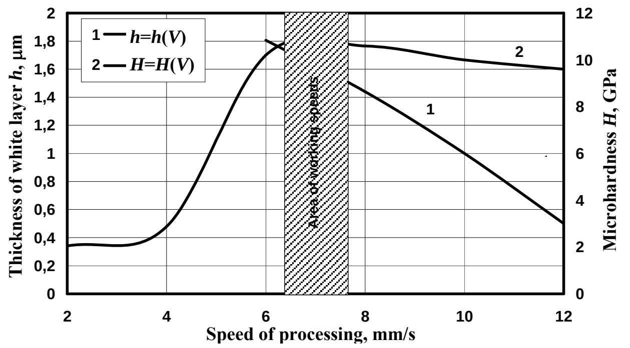

Fig. 4 Influence of EMH speed on microhardness and white stratum width

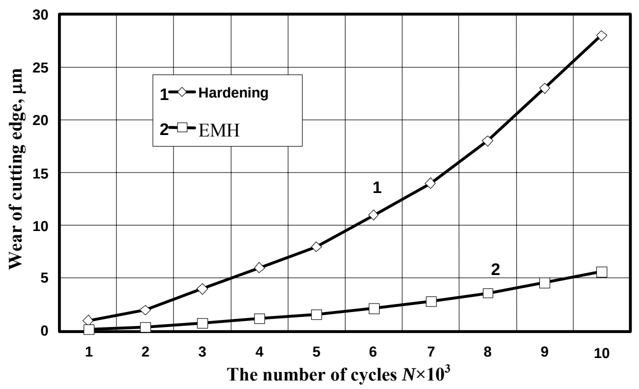

Fig. 5 Wear of cutting edge of the tool

It is necessary to mark, that the given dependencies essentially differ from conventional ones for EMH of revolution surfaces. It is caused by considerably higher densities of the current and small handling speeds necessary to obtain the major width of white stratum. Thus, at restricted mass of the hardened workpieces the relation between an amount of contact brought in a band, heat and heat sink become the dominating significance.

Thus it is possible to select three distinctive cases of thermal effect on threated surface:

- the current density is less than minimum necessary for white stratum formation;
- the current density is in an interval of values providing white stratum formation. With current density increase in this area the width of white stratum is augmented up to maximal;
- the current density exceeds some maximal value and there is a violation of necessary speed of the heat sink.

Thus on the surface the secondary tempering band is shaped unhardening the structure of which practically does not differ from the structure of white stratum detected at the metallographic analysis, but the microhardness practically will match to the microhardnesses nonhardened material.

If there is practical interest to determine the temperature effect on secondary tempering of white stratum, it will allow to determine minimum distance between adjacent tracks at forming on the workpiece of several cutting edges.

Exploration of temperature effect of secondary tempering on white stratum microhardness of steels У8А and У10 at static and high-speed heating relevant to heat rate at EMH have shown, that with temperature increase of secondary tempering the microhardness of white stratum is diminished, and, at static heat is more intensive, as contrasted to high-speed. The adequate change of microhardness at high-speed heating is dislodged in the area of higher temperatures of about 200 K as contrasted to static heat that is explained by the difficulty of structural transiting in the metal.

It is necessary to mark, that up to temperature 700 K at heat rate relevant to EMH process, the microhardness of white stratum essentially is not diminished.

4. Conclusions

From the explorations results technological guidelines were developed, according to which the batch of tools (material У8А) was treated and the comparative industrial testing was performed.

The wear was evaluated on magnification of radius at vertex of a cutting edge of an experimental batch of tools, the cutting edge of which were formed by EMH and serial volumetric quenching with a low tempering on standard technique (Fig. 5). The cutting stability of tools, hardened by EMH, has increased 5 - 6 times as compared to serial tools, that confirms high performance of the offered method.

The designed technique can be recommended for the manufacture and hardening of cutting edges of tools for impregnated-paper, textile, food and other branches of manufacture.

References

1. **Аскинази Б.М.** Упрочнение и восстановление деталей машин электромеханической обработкой. -Москва: Машиностроение, 1989.-197с.
2. Электромеханическая обработка. В.П. Багмутов, С.Н. Паршев, Н.Г. Дудкина и др. -Новосибирск: Наука.-318с.
3. **Бабей Ю.И.** Механическая обработка, как способ повышения долговечности конструкционных сплавов в активных средах. -ФХММ, 1975, No2, с.3-14.
4. **Паршев С.Н.** Формирование режущей кромки лезвийного инструмента электромеханической обработкой. -Вестник машиностроения, 1999, No5, с.31-35.
5. **Аскинази Б.М.** Расчет усилий электромеханического сглаживания. -Исследование и применение процессов электромеханической обработки металлов.-Ульяновск: УСХИ, 1970, т.17, Вып.1, с.13-27.

V.P. Bagmutov, S.N. Parshev, N.Y. Polozenko

PJOVIMO ĮRANKIŲ PJAUNANČIOSIOS BRIAUNOS MECHANINIŲ SAVYBIŲ GERINIMAS ELEKTROMECHANIŠKAI APDIRBANT

R e z i u m ė

Elektromechaniškai apdorojant pjovimo įrankius formuojama pjaunančioji briauna, kurią sudaro labai dispersiškas martensitas (baltasis sluoksnis), pasižymintis dideliu stiprumu ir atsparumu dilimui. Nustatytos baltojo sluoksnio susidarymo energetinės sąlygos esant ribotam šilumos išsiskyrimui. Pastebėti baltojo sluoksnio, kurio storis lygintinas su sustiprinamo įrankio matmenimis, susidarymo ypatumai.

V.P. Bagmutov, S.N. Parshev, N.Y. Polozenko

IMPROVEMENT OF MECHANICAL CHARACTERISTICS OF A CUTTING EDGE OF THE BLADE INSTRUMENT BY MEANS OF ELECTROMECHANICAL PROCESSING

S u m m a r y

It is shown, that in case of electro mechanical handling (EMH) of the blade instrument shaping of the cutting edge consisting of high dispersible martensite (a white stratum) is taking place, which is distinguished by heightened durability and endurance. Energy requirement of white stratum's forming in case of the restricted heat sink are established. The features of white stratum formation by the width commensurable with the sizes of the hardened instrument are discussed.

В.П. Багмутов, С.Н. Паршев, Н.Ю. Полозенко

ПОВЫШЕНИЕ МЕХАНИЧЕСКИХ СВОЙСТВ РЕЖУЩЕЙ КРОМКИ ЛЕЗВИЙНОГО ИНСТРУМЕНТА ЭЛЕКТРОМЕХАНИЧЕСКОЙ ОБРАБОТКОЙ

Р е з ю м е

Показано, что при электромеханической обработке (ЭМО) лезвийного инструмента происходит формирование режущей кромки, представляющей собой высокодисперсный мартенсит (белый слой), отличающийся повышенной прочностью и износостойкостью. Установлены энергетические условия формирования белого слоя при ограниченном теплоотводе. Отмечаются особенности образования белого слоя толщиной соизмеримой с размерами упрочняемого инструмента.

Received February 17, 2005