13. Булгаков В.М., Головач І.В. Уточнена теорія викопуючого робочого органу лемішного типу // Вісник аграрної науки Причорномор'я. Спеціальний випуск 4(18). Том І. – Миколаїв: МДАУ, 2002. – С. 37-63.
14. Булгаков В.М. Бурякозбиральні машини [Текст] : монографія / В.М. Булгаков. – К: Аграрна наука, 2011. – 351 с.
15. Zuckerrüben: Erntetechnik und Bodenschutz / FAT-Berichte Nr. 567//Eidgenssische Forschungsanstalt für Agrarwirtschaft und Landtechnik (FAT), CH-8356 Tänikon TG – 2001 P. 1-19.
16. Roller O. Entblatten statt Köpfen / Dr. Olaf Roller // Zuckerrüben Journal № 2 // Rheinischer Landwirtschafts-Verlag GmbH. – 2010, P. 14-15.
17. Merkes R. 50 Jahre Prodaktionstechnik im Zuckerrübenbau in Deutchland / R. Merkes // Zuckerrübe. – 2001, № 4. – P. 214-217.
18. Es geht um den Kopf / Zuckerrüben Journal №3 // Rheinischer Landwirtschafts-Verlag GmbH, – 2010, P. 7-8.

Vladimir Bulgakov, Prof., DSc., Ivan Holovach, Prof., DSc.
National University of Bio-resources and Environmental Sciences of Ukraine, Kiev, Ukraine
Mykhailo Chernovol, Prof., DSc.
Kirovohrad National Technical University, Kirovohrad, Ukreine

Theoretical background research oscillation vibration at its root digging

The task to develop the basic tenets of the theory of vibrations sugar beet roots as elastic bodies in an elastic environment and get them on the process parameters that provide neposhkodzhennya roots.

The paper contains theoretical research translational vibrations beet root as a rigid body in an elastic medium, together with the surrounding soil, root crops betrayed by digging out the vibration of the working body in the longitudinal vertical plane. A system of differential equations of this oscillatory process, the solution of which made it possible to determine the amplitude and frequency of vibrations to ensure complete destruction of root relations with the soil and creates preconditions for its eventual recovery.

root, vibratory excavating a working body, translational vibration frequency, amplitude, the system of differential equations

Одержано 06.11.15

УДК 621.9.048

Aleksandr Mazheyka, prof., PhD tech. sci.
Kirovograd National Technical University, Kirovohrad, Ukraine

Features a combined laser processing of titanium-nickel alloys

The article describes a study of the combined laser processing (CLP) for coating of titanium-nickel alloy. The structural phases that are inherent in shape memory alloys, for a considerable time by X-ray analysis. The dependence of the volume fraction of martensite, depending on the depth. It was determined that the main mechanism of relaxation during the laser treatment is combined partial martensitic transformations in phase B2 in B19. The studies confirm the effectiveness of CLP.
surface, metal materials, crystal phase, combined laser processing, X-raystructure researches, diffractive pictures

А.И. Мажейка, проф., канд. техн. наук
Кировоградский национальный технический университет, г.Кировоград, Украина

Особенности комбинированной лазерной обработки никель-титановых сплавов

В статье описано исследование технологии комбинированной лазерной обработки (КЛО) для получения покрытий из титан-никелевых сплавов. Исследованы структурные фазы, которые присущи сплавам с памятью формы, на протяжении значительного времени с помощью рентгеноструктурного анализа. Установлена зависимость объемной доли мартенсита в зависимости от глубины залегання. Определено, что основным механизмом релаксации при проведении комбинированной лазерной обработки является частичные мартенситные превращения фазы В2 в В19. Проведенные исследования подтверждают эффективность проведения КЛО.
поверхность , металлические материалы, кристаллические фазы, комбинированная лазерная обработка, ренгеноструктурный аналіз, ДРОН-7, дифракционные фотографи

Now in the world methods of modification of a surface of metal materials with use of the concentrated streams of energy which allow to shape superficial layers with new physical properties are actively developed, keeping thus initial properties of a material in its internal volume [1].

Crystal and amorphous phase conditions inside of these layers, as a rule, are metastable as are shaped in strong nonebalans conditions of heats, pressure and ultrahigh speeds of heating and cooling .

The saved up experimental data show, with what exactly these synthesized nonequilibrium conditions in near-surface areas of materials provide occurrence in last new atypical properties which find the important application in practical spheres of activity.

However data about the synthesized structurally-phase conditions, their interrelations with variation of superficial properties of materials are extremely limited, and mechanisms of their formation till now slightly are studied.

It is known, that power influences on a surface of materials cause occurrence of important fields of the internal pressure localized in near-surface volumes .

Except for variation of mechanical properties in zones of localization of these fields of pressure (hardening, increases of fragility, hardness), are available data about their negative influence on chemical properties of materials, for example, lowering of corrosion stability .

Alloys on the basis of nickelid the titan with effect of memory of the form with advantage win the right of use as materials for medicine owing to proximity of their elastic-mechanical characteristics to elastic properties of biofabrics.

However existing danger of an output of highly toxic nickel on biowednesday owing to its high concentration in structures of the given alloys forces to look for ways of formation on their surface barrier, the blanket providing high corrosion stability and, consequently, raising their biocompatibility.

Carried out before research have shown perspectivity of use for these objectives of the combined laser processing (the combined laser processing – KLP),. It has been established, that as a result of these influences the nonequilibrium structurally-phase conditions localized in near-surface zones of influences, with gradients of structural parameters are shaped.

Variations of thin atomik-crystal structure in the synthesized layers probably to investigate only with use of not destroying x-ray structural methods.

Problem formulation. In work results X-raystructure researches nonequilibrium structural and elastic pressure the conditions which have generated in near-surface layers nickelid of the titan as a result of combined process of laser superfast and local heating of materials with fusion are presented Powder material and mechanical plastic deformation that allows to solve appreciably problems characteristic both for cleanly laser processing, and for processing SPD (surface plastic deformation), i.e. to shape the strengthened layers with structures,

Possessing all dignity of structures of laser training and having characteristics favorable from the point of view of fatigue strength and wear resistance, as well as the analysis of character of distribution of microdeformation of bar B2-fase caused by such influences.

Samples of alloy TiNi were in a biphase condition from the basic phase with structure V2 (OKC, ordered as CsCl, the temperature has begun direct martensits transformations B2→Б19 ' Мн and 283 T^o; parameter of a bar aoB2 0,30125 ± 0,00005 nanometers, appropriating structure Ti_4Ni; 5Ni50,5) and a small amount (<5 % about.) intermetallide phases Ti_2Ni metal.

Objective of research. Researches of the structurally-phase conditions generated as a result of combined influences in near-surface areas of samples TiNi, spent at once and in 1 year after an irradiation methods X-ray diffraction the analysis (PCA) on diffractometr DRON-7 with use symmetric and asymmetric (with variation of angle of slipping of diagrams of reflection with lengths of waves of x-ray radiation Co-Ka, Cu-Ka).

With choice of angle and in asymmetric x-ray shootings provided identical effective thickness of a reflecting layer h at all angles Bregss reflections on a procedure described in [2].

Size of microdeformation of a bar of phase B2 in near-surface areas (caused by pressure of the first sort, along a direction defined by angle) defined on variation of parameter of a bar of this phase in the irradiated samples

$$\varepsilon_{\psi}^{I} = \frac{a_{\psi} - a_0}{a_0}$$

where, a_0 – parameter of a bar of phase B2 in the initial sample;

$a\psi$ – parameter of a bar of phase B2 in the irradiated sample, measured in a direction of angle ψ = ®ш - and between normals to a plane of a surface of the sample and to a plane of reflection (hkl); hhi – angle bregs reflections; and – angle between a direction of a primary bunch and a plane of a surface (angle of slipping).

Division on normal and a tangent (to a plane of a surface) components of microdeformation spent with use extrapolation charts a (sin^2) and to definition on them of values aф (ψ = 0 conforms to value of parameter of a bar of phase B2 and, accordingly, its microdeformations along a normal to a plane of a surface of the sample, And ψ = 90^0 – along a tangent to this plane).

Research results. At use of the asymmetric diagram of reflection angle and reduced up to and = 0,1 (without rotation of the sample), smaller, than angles of full reflection of X-rays of the chosen lengths of the waves, theoretically calculated for nickelid the titan (for both types of radiation 0,3 <ati-p <0,4).

However even at such small coal of slipping it was possible to observe precise diffractions picture with availability of four-five diffractions B2 – reflection with halfwidths nearby 1, similar resulted on fig.1.

Apparently, that supervision diffractive pictures under angles, smaller rated angle of limiting reflection for the given material, is caused by availability of a nonzero roughness of a surface of experimental samples.

For reduction instrumental broadening x-ray structures used narrow (0, 05 mm) target cracks, as well as reduced the area of a surface of the sample shined by a x-ray bunch.

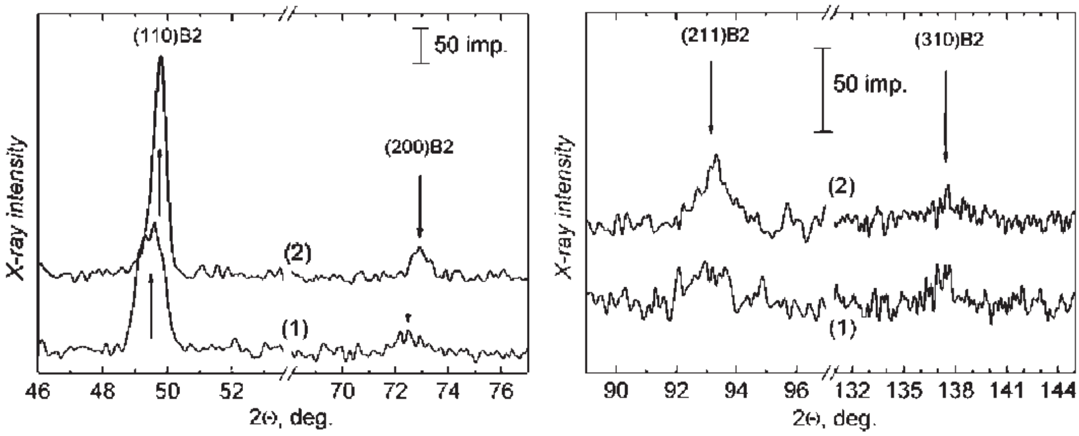

Figure 1 – Fragments diffraction patterns alloy Ti_4G, 5Ni50,5 with the superficial layer modified by combined laser processing, received at use of asymmetric diagrams of reflection with angles of slipping and = 0,15 (1), and = 2 (2); radiation Co-Ka

Source: created by the author

All this has allowed to estimate sizes of microdeformations in a superficial layer in thickness up to 50 nanometers.

In work [3], it has been established, that on the processed side the superficial layer which differs in the structural parameters from structure of samples TiNi before processing always is formed.

This layer is characterized by a single-phase structural condition with structure B2 having smaller parameter of a bar, than in its condition up to an irradiation, and a sharp structure that was showed in occurrence on diffractograms intensive superstructural (100) B2 and structural (200) B2 reflexes,

Completely disappearing at variation of angular orientation of the sample concerning a primary x-ray bunch.

It has been shown, that this layer has columnar the structure made of monocrystals with the sizes of areas of coherent dispersion in a direction of a normal to a surface of the sample more 150 nanometers, significantly surpassing the linear sizes of the basis separate rystallid.

The assessment elastic stress conditions synthesized B2 columnar structures has shown availability in it to significant microdeformation of a bar e1 ±1 the %, caused by pressure of the first sort, and rather smaller microdeformation of a bar e11 = 0,25 %, caused by pressure of the second sort.

Pressure of the first sort, possibly, arise at variation of the external conditions accompanying laser influence (propagation of temperature front, an elastic wave, speed of cooling, duration and quantity of impulses, etc.) and are counterbalanced in all things volume of the sample.

Pressure of the second sort are caused by microdistortions in the structure which has generated after an irradiation.

Apparently, elastic pressure the outer layer is the concentrator of pressure for underlaying (intermediate between an outer layer with the synthesized structure and internal volume of the material, remained without variation) layers nickelid the titan and should influence structural conditions of phase B2 in these layers. Really,

Research results. The analysis of pictures of x-ray diffraction from the samples, subjected to influences KLP, has shown, that in the layers laying under external recrystallized by a layer, the parameter of a bar of phase B2 naturally changes in dependence both on thickness of an analyzed layer, and on mutual orientation of a primary bunch and a plane of a surface of the sample, that is from a direction of measurements.

At construction of dependences of parameter from function $\sin^2 \Phi$ which receive at use of a method of asymmetric shootings, in [2] it has been shown, that after an irradiation in samples TiNi linear increase with growth $\sin^2$ is observed F.Ugly of a slope of straight lines aB^2 ($\sin^2$) depend on thickness of effectively reflecting layer, however are always positive, so. It is shown, that the reason for such behaviour aB^2 are the fields of elastic pressure localized in near-surface layers of a material, was in a zone of influence by an electronic bunch.

On a slope of straight lines aB^2 ($\sin^2$) it is certain reference point radiation dependence and type (compression/stretching) elastic pressure conditions which is shaped in an investigated phase.

It is shown, that after electron beam processing in a near-surface layer in thickness up to 15 microns, along a normal to a plane of a surface pressure of compression, and in tangents directions to it – pressure of a stretching are induced. At the same time with it sizes ав2, measured under angle $\Phi = 45^0$, are close to the values in the initial sample, that is, average value of parameter of a bar of phase B2 in the elastic-strained layer remains former and consequently, and the concentration parity between Ti and Ni inside of this layer has not changed.

The assessment of size of microdeformation £ψ of a bar of phase B2 (micropressure of the first sort), lead earlier, right after electron beam influences on samples, has shown, that in an outer layer in thickness up to 1-3 microns it accepts the greatest values and decreases with an increase of thickness of a reflecting layer.

The sizes of microdeformation £ψ calculated on difractograms, removed in 1 year after an irradiation of samples, and resulted in the given work, have shown availability relations process in a superficial layer in thickness less than 1 micron which was showed in variation of character of dependence of micropressure from thickness of a reflecting layer. So, on fig. 2 dependences of microdeformation £ψ on thickness of a reflecting layer for mutually perpendicular directions appropriating $\psi = 0$ and $\psi = 90$ are presented. From picture it is visible, that right after an irradiation a tangent (type of a stretching) the component of microdeformation £ψ=до (point) reaches the greatest values in a superficial layer in thickness less than 2 microns.

In 1 year after an irradiation of the sample this dependence remains constant (point).

On the contrary, normal (N) a component of microdeformation £ψ=o (point) right after an irradiation reaches type of compression of the greatest (on absolute size) values in a superficial layer in thickness less than 1 micron, and in 1 year after an irradiation of the sample is observed reduction of its absolute values from them oscillations about zero in the modified layer (point).

On depth from a surface more than 1 microns of value £ψ=o received at once and in 1 year after an irradiation, practically have coincided. It means, that on depth from the irradiated surface more than 1 microns of a relaxation of elastic pressure has not occured.

The small divergence in a range of thickness 1-4 microns of values £ψ=o received through noted time interval, apparently, is caused by the contribution relaxations a layer in diffractions picture

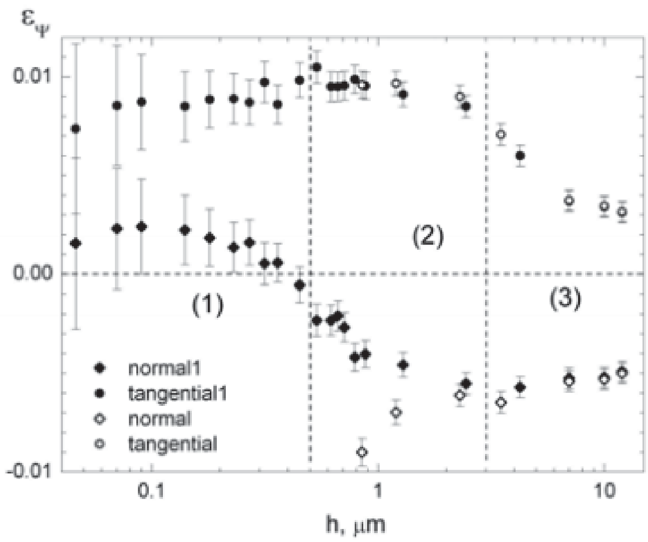

Figure 2 – Dependences on thickness of a reflecting layer a component of microdeformation of a bar of phase B2 e * = 0 (About,) and £ψ =д0 » (about,) in samples TiNi irradiated KLP about, O – right after irradiations; – in 1 year after an irradiation

Source: created by the author

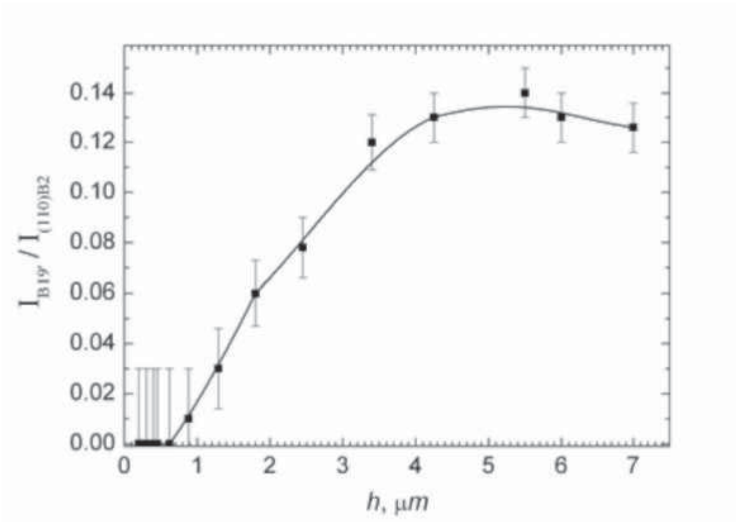

Figure 3 – Dependence of the attitude of total intensity of reflexes B19 ' to intensity of a reflex (110) B2 IBlg'Л (110) B2 иB19 '/B2 from thickness of effectively reflecting layer, received right after electron beam processing of sample TiNi

Source: created by the author

As it was marked, the alloy from which samples have been prepared, tests m transformation B2-B19 ' which temperatures lay near to a room temperature (Tr).

It means, that, first, at occurrence of internal fields of elastic pressure in samples phase B19 ' as a result of deformation transformation B2→B19 ', and, secondly, can to appear martensits phase B19 ' can be observed on the roentgenograms which have been removed not in temperature chambers, and at Тк. Really, on diffractograms.

The asymmetric shootings received by a method, in a range of angles 38 <20 <44 (for radiation Cu-Ka) precise enough reflexes from martensits phases B19 ' [2] which intensity changes depending on angle of slipping are observed and.

As noted angular range of shootings is conformed with thickness of a reflecting layer 6-7 microns (for radiations-K and Cu-Ka accordingly), it means, that martensit phase B19 ' is induced in a layer laying below external (with columnar structure).

Dependence on thickness of a reflecting layer of the attitude of total intensity of revealed reflexes B19 ' to intensity of a reflex (110) B2, describing a parity of volume fractions martesit and high-temperature phases B19 '/2 inside of all layer participating in reflection of X-rays, is illustrated on fig.

From this dependence the volume fraction martensits phases which near to a surface is minimal follows, that, changes in near-surface volume on a curve with the maximum falling depth from the irradiated surface of 4-6 microns with the tendency of reduction in deeper layers.

From comparison of dependences on fig.2 and 3 follows, that correlation in variation of microdeformation of a bar (caused by pressure of the first sort) in phase B2 and quantities martensits phases Б19 ' is observed at an increase of thickness of an analyzed layer.

So, on depth 3-6 microns from a surface both components essentially decrease on absolute size while the attitude at the most, i.e. behaves similarly to the module of derivative function:.

Differently, deformation of a bar of phase B2 essentially decreases when in a layer occurs partial deformation mfrtensits transformation B2-B19 ' which, apparently, causes partial removal of internal pressure in basic phase B2 inside of the modified layer.

Thickness of a layer in which are observed relaxations processes with the mechanisms of a relaxation caused martensits by transformations B2-B19 ', on x-ray data makes 10-15 microns.

It is necessary to note, that despite of essential decrease in intensity of all diffractions reflexes at transition to sliding shootings, on appropriating diffractions pictures from samples TiNi after lasers influences of reflexes B19 ' it was not observed.

It means, that in an outer layer with columnar structure V2 deformation martensits transformation B-19 ' does not proceed [3].

Thus, it is established, that after an irradiation of samples TiNi KLP on the irradiated side it is formed crystal a superficial layer with a sharp structure, which is in elasticpressure a condition and is characterized by microdeformation of a bar of phase B2 caused by pressure of the first and second sort important component of microdeformation e1 shows and the synthesized layer with столбчатой structure is the concentrator of internal pressure for underlaying layers of a material.

Conclusions. It is revealed, that in elastic pressure (intermediate) layer located under external the changed crystallization by a layer, process of a relaxation of the internal pressure induced by an irradiation develops.

It is shown, that the basic mechanism of such relaxation is partial deformation martensits transformation B2-B19 '. Availability martensits phases B19 ' inside of an intermediate layer leads to reduction of size of microdeformation of a bar in phase B2 adjoining it, that to greater, than more volume fraction martensits phases in a layer.

Thickness of a layer in which develop relaxations processes on the mechanism deformation martensits transformations B2-B19 ', makes 10-15 microns.

References

1. Мажейка О.Й. Лазерна, плазмова і детонаційна технології зміцнення поверхонь [Текст] : монографія / О.Й. Мажейка. – Кіровоград: вид. Лисенко В.Ф., 2011. – 260 с.
2. Миркин Л. И. Справочник по рентгеноструктурному анализу поликристаллов [Текст] / Л. И. Миркин. – М.: Физматгиз, 1968. – 864 с.
3. Мажейка А.И.Управление изменениями в твердых телах лазерным излучением [Текст] : монография / А.И. Мажейка. – Кировоград: «Код», 2010. – 236 с.

О.Й. Мажейка, проф., канд. техн. наук
Кіровоградський національний технічний університет, м.Кіровоград, Україна

Особливості комбінованої лазерної обробки никель-титанових сплавів

Метою роботи було визначення параметрів структур нікель-титанових сплавів при комбінованій лазерній обробці.

В статті описано дослідження технології комбінованої лазерної обробки (КЛО) для отримання покриттів з титан-никелевих сплавів. Досліджені структурні фази, яки притаманні сплавам з пам'яттю форми, на протязі значного часу за допомогою рентгеноструктурного аналізу. Встановлена залежність об'ємної долі мартенситу в залежності від глибини залягання. Визначено, що основним механізмом релаксації при проведенні комбінованої лазерної обробки є часткові мартенситні перетворення фази B2 у B19.

Деформаційні зміни структур сплавів TiNi при комбінованій лазерній обробці призводять до загартування поверхневих шарів і може бути використовано при зміцненні деталей сільськогосподарської техніки.

поверхня, металеві матеріали, кристалічні фази, комбінована лазерна обробка, рентгеноструктурний аналіз, ДРОН-7, дифракційні фотографії

Одержано 30.10.15

УДК 631.319.2

В.М. Булгаков, проф., д-р техн. наук, академік НААН України, І.В. Головач, проф., д-р техн. наук
Національний університет біоресурсів і природокористування України, м.Київ, Україна
В.П. Горобей, канд. техн. наук
НВО "Селта" Національного наукового центру "Інститут механізації та електрифікації сільського господарства"
М.О. Свірень, проф., д-р техн. наук
Кіровоградський національний технічний університет, м.Кіровоград, Україна

Побудова математичної моделі коливального руху у ґрунті зубчастого сошника селекційної сівалки

Для розробленої нової конструкції комбінованого сошникового вузла створена теорія руху у ґрунті зубчастого розрізаючого диска сошника селекційної сівалки, встановленого на вібраційній підвісці. Складені диференціальні рівняння горизонтальних і вертикальних поступальних коливань лонжерона комбінованого сошникового вузла з зубчастим розрізаючим диском і системою пружинних механізмів з натискною пружиною і пружиною вібратора для вивчення впливу віброефекту на тяговий опір сошника. Отримана математична модель дала змогу визначати амплітуди і частоти поступальних коливань лонжерона комбінованого сошникового вузла в залежності від конструкційних параметрів і кінематичних режимів роботи з метою визначення їх впливу на технологічний процес, що дозволить оцінити стан системи і оптимізувати енергетичні характеристики універсальної сівалки.

сівалка, універсальний комбінований сошник, зубчастий диск, пружина, сила, реакція ґрунту, диференціальні рівняння, коливання,синусоїдальний закон, амплітуда, частота