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(54) METHOD FOR CREATING IMAGES

(57) The present invention applies to technology of a laser treatment for the solid materials, in particular, to the technology of image formation into volume of the transparent wares with different colour effects.

In comparisons with the known methods of formation of three-dimensional intra-volume images that consist in the focusing of a laser radiation to the prescribed point into volume of transparent sample, its irradiation with power density that exceeds the threshold value of volume breakdown of the material and a movement of the sample relatively to a laser beam according to prescribed law, this submitted method ensures a possibility to form the three-dimensional coloured intra-volume images.

To achieve the above technical result in the mentioned method for formation of three-dimensional intra volume images, every dot of forming image into transparent sample is fired with the focused laser radiation with a power density that exceeds the threshold value of optical volume breakdown of the material. But as distinct from the prototype, a porous material is used as a transparent material, and that porous stuff contains, at least, one substance that changes irreversibly its physical and chemical characteristics by influence of factors of optical volume breakdown into volume of a transparent material.

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Description

APPLICABLE FIELD

[0001] The present invention applies to technology of a laser treatment for the solid materials, in particular, to the technology of image formation into volume of the transparent wares with different colour effects.

PREVIOUS TECHNOLOGY LEVEL

[0002] There is a certain method to make hatching on a surface of the transparent solid materials [1], by depositing a layer of powdery dyestuff on under-layer, by placing a processing transparent sample on that layer and by focusing a laser radiation to the dye layer. At this moment, by impacting of laser radiation in a dot on the layer of the absorbing dye, the last one is heated and implanted into a surface of the processing sample. The hatching is obtained by scanning of a laser radiation on a layer of the dye. A merit of above method is high exactness of hatching. The demerits of the method is a damage of a surface of the transparent sample and impossibility to form an image inside volume of the transparent sample.

[0003] There is a certain method for marking of ceramic materials, glazes, glass ceramics and glasses [2], that consists in the following: during preparation of the above materials, some photo-sensitive add-ons are inserted into them, and these add-ons absorb a laser radiation and change their colours in radiation zone. The prescribed image is obtained by moving of the sample relatively to a laser beam. A merit of above method consists in the following: colour marking is performed without damaging to integrity of a surface of the process sample. Demerit of above method [2] that marking is localized only on a surface of the sample because the photosensitive add-ons absorb a laser radiation directly on its surface. So it is impossible to obtain the intra volume three-dimensional images by that method.

[0004] There is a certain method to form the images inside volume of sample that consists in the following: am image is formed with an electronic pencil [3], or an electric discharge [4] inside volume of sample of transparent material. But an image formed in such way has some grave shortcomings, because a sample's surface is damaged due to an influence of an electronic pencil or an electric discharge. And also an image is entirely formed as stringer channels of breakdown and therefore it cannot be considered as a random three-dimensional one.

[0005] There is a certain technique to form images that consists in the following: a light-scattering image inside volume of sample of transparent material is formed with a laser by focusing of a laser radiation in prescribed point of volume with a power density that exceeds the threshold value of optical volume breakdown of sample's material [5]. The method [5] is considered as the nearest to the submitted invention on the basis of the essential characteristics and, therefore it is chosen as the nearest analogue-prototype. The prescribed image is formed by dots by moving an object relatively to a laser beam in three mutually perpendicular directions according to the prescribed law. The method [5] enables to form the prescribed three-dimensional images in volume of sample of transparent material with saving of an integrity of its surface. That method can be applied for formation on any prescribed three-dimensional images in volume of wares of transparent material: logotypes, trademarks, marks and etc. Demerit of the method [5] is a colourlessness and low contrast of obtained image, because the image is formed from the colourless zones of a laser lesion in transparent material and it is got visible only by scattering a radiation of outer light source. The colourlessness and low contrast of obtained image greatly eliminate an artistic finish and appearance of goods with intra volume images.

[0006] A task to be solved with submitted method is to produce wares with coloured intra volume images and an achievable technical result is to obtain the coloured intra volume and three-dimensional images.

INVENTION DESCRIPTION

[0007] To achieve the above technical result in the mentioned method for formation of three-dimensional intra volume images, every dot of forming image into transparent sample is fired with the focused laser radiation with a power density that exceeds the threshold value of optical volume breakdown of the material. But as distinct from the prototype, the porous material is used as a transparent material, and that porous stuff contains, at least, one substance that changes irreversibly its physical and chemical characteristics by influence of factors of optical volume breakdown into volume of a transparent material. A usage of transparent sample of various kinds of porous material (e.g. porous glass), enables to add a cclourless or slightly coloured substance into volume of transparent sample before a process of a laser radiation. And such colourless or slightly coloured substance changes its colouring by an influence of factors of an optical volume breakdown and the subsequent treatment (e.g. chemical, thermal, light, acoustic).

[0008] As is generally known (refer[6]), a process of volume optical breakdown in transparent medium is accompanied with a plasma generation localized in focusing point of a laser radiation. This plasma has a quite high temperature and an ionization rate. Such plasma effects on the material of transparent sample of a porous glass with inserted substance and it changes the physical and chemical characteristics of the material. Thus, the following factors of influence on the material are arisen:

a) an irradiation with a plasma radiation (photon

influence),

b) a heating, a melting and an evaporation (thermal influence),

c) a plasma-chemical reactions that are proceeded in highly ionized plasma (a plasma-chemical influence),

d) an expansion of a wave of high pressure - i.e. a shock wave (a pressure influence).

[0009] If the components that are sensitive to any factors (or their combination) are inserted into the sample, so each of these factors taken separately or their combination may be used for obtaining of colouring effect for a breakdown zone and a sample's area adjoining to it. For example, if the components that are sensitive to plasma's radiation of a laser breakdown and in the same time, are non-reacting to a radiation with wavelength of a laser generation, are inserted into the sample, so as a result of an irradiation with a laser plasma's light, the optical characteristics (an absorption spectrum) of inserted components are changed in the zone of a laser breakdown and the area adjoining to it. Thus, the colours of that area are changed. The dimensions of the coloured area will be specified both by optical characteristics of the component, (an absorption rate), and by its concentration. The higher an absorption rate and a concentration of photosensitive component are, the less area where an effect of colouring change will be localized in. A problem of selection components that are insensitive to plasma's radiation and in the same time, are reacting to a radiation of a laser breakdown, may be easily solved, because a plasma's radiation, owing to its high temperature, shifted to ultraviolet part of spectrum. Where almost all of the known photomaterials (e.g. on a basis of silver halides) have a high sensitive [7]. In the same time a lot of photo-materials are insensitive to a radiation in long-wave part of the spectrum. Therefore, if a laser radiation in red or infrared part of the spectrum (e.g. a laser with alum yttrium garnet - 1.06 μm or a ruby - 649.3 nm) is used for an initiation of intra volume breakdown, so the colouring changes will be localized in area of intra volume laser breakdown. By moving a processing sample according to prescribed law, a three-dimensional coloured pattern will be formed in volume of a transparent sample.

[0010] In the same way an effect of a thermal impaction may be used for colouring change in an area of a laser breakdown. In this case, the following components are to inserted into a transparent sample: either the components that change the spectrum of an absorption (colouring) as a result of heating, or the components that react with each other as a result of heating with a formation of new components which have colours different from ones of the original components. Such substances are well known - e.g. ammoniac metavanadate that has a white colouring in an original condition and decomposes at 150°C to the components that have a red-yellow colouring [8]. A localization of effect of colouring changes is provided by the following condition: high temperature heating is localized in the area of a laser breakdown.

[0011] In the same way, an effect of plasma chemical influence and shock wave's impact may be used to change a colouring in area of laser breakdown. Due to such influences the physical and chemical characteristics of molecules inserted into the transparent sample of substance are changed.

[0012] Apart from that, the obtained coloured image can be strengthened and/or intensified by additional treatment of the sample. All the physical and chemical reactions are described in [9].

[0013] It is possible to make a different implementation of the method: after an irradiation, at least one more substance is added into a transparent sample and this substance reacts with, at least, one originally inserted substance modified by factors of an optical breakdown. This variant ensures a chemical strengthening and/or intensifying of formed coloured images with an additional reagent.

[0014] It is possible to make a different implementation of the method: after an irradiation the sample undergoes thermal treatment.

[0015] It is possible to make a different implementation of the method: after an irradiation the sample undergoes additional optical treatment.

[0016] It is possible to make a different implementation of the method: after an irradiation the sample undergoes the additional treatment of sound waves.

[0017] An advantage of the submitted method and possibilities of its implementation are shown in undermentioned examples.

EXAMPLES OF INVENTION IMPLEMENTATION

[0018] A composition of a transparent sample and chemical add-ons that change irreversibly their physical and chemical characteristics by the influence of factors of an optical breakdown and that are suitable in the proposed invention are maybe quite different. Due to the high energy density in the field of the focusing of laser radiation, the large physical and chemical transformations of these substances are possible. Beneath only some of possible examples of the invention implementation are given. All the happening chemical reactions are described in e.g. [7,9].

Example 1

[0019] A sample of porous glass may be used as a transparent object and that glass was obtained by a lixiviation of an article of sodaboro silicate glass DB1m in a solution of hydrochloric acid. A pore volume is 0.3 cm^3/cm^3 (in average pore diameter of 8 to 10nm). After rinsing in distilled water, a thermal treatment at 450°C within 40 minutes and a vacuum drying, the obtained samples are polished and implanted with a photosensi-

tive salt of AgBr by consequent dipping into the liquid solutions of KBr, $AgNO_3$, KBr with following rinsing in distilled water and drying. The obtained in such way samples are fired by a laser radiation focused into volume with an alum yttrium garnet with wavelength of 1.06μm and power sufficient for arising of intra-volume breakdown. As a result of the irradiation of the laser breakdown's plasma in its localization places with an ultraviolet radiation, the dark-brown zones are appeared with dimensions of ~ 0.1 mm (a mode of direct blackening). To strengthen a colouring (optical density), the samples, after the irradiation, are treated with a diluted developing-fixing solution LIKI with subsequent rinsing into distilled water.

Example 2

[0020] The samples of porous glass obtained according to the example 1 may be saturated by dipping into liquid solution of potassium ferroxasalate that is photosensitive to ultraviolet radiation with a formation of ferrous salt. After an irradiation of the obtained samples in the mode of an optical intra-volume breakdown by a laser radiation on alum yttrium garnet, the samples are saturated with a solution of ferricyanic potassium. As a result of chemical reaction of ferrous iron with ferricyanic potassium, the zones of intensive blue colouring are appeared.

Example 3

[0021] The samples of porous glass obtained according to the example 1 may be saturated by dipping into liquid solution of potassium ferroxasalate that is photosensitive to ultraviolet radiation as the same as in the example 2. After an irradiation of the obtained samples in the mode of an optical intra volume breakdown by a laser radiation on alum yttrium garnet, the samples are saturated with a solution of 1.10-phenanthryl. As a result of chemical reaction the zones of intensive red colouring are appeared.

[0022] The submitted invention can be widely used for formation of coloured intra-volume images into the transparent materials, such as souvenirs and lamps. An application of proposed method for formation of coloured intra volume images into the transparent wares may improve an artistic finish and appearance of above goods.

REFERENCE MATERIALS

[0023]

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2. H. Gugger ,F. Herren, M. Hoffman, A. Pugin. Laser marking of ceramic materials, glazes, glass ceramics and glasses. US Parent #4,669,310.

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5. S. Oshemkov. Method of laser formation of images into solid media. USSR patent #2008288. 1994.

6. G. Rady. Effects of laser radiation. Moscow. Mir. 1975.

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9. Non-silver photographic process. Leningrad. 1984.

Claims

1. A method for formation of coloured images consisting of the following: every point of the forming image inside a volume of transparent sample is fired with a laser by focusing laser radiation with a powder density that exceeds the threshold value of optical volume breakdown of the material characterised in that porous material is used as the transparent sample, and in that at least one substance is implanted into the above porous material and this substance changes irreversibly its physical and chemical characteristics by the influence of factors of an optical breakdown in the volume of the transparent sample.

2. A method according to claim 1, wherein after irradiation, at least one more substance is added to the transparent sample and that substance reacts with, at least one originally inserted substance modified by the influence of factors of an optical breakdown.

3. A method according to any one of claims 1 to 2 wherein after irradiation, the sample undergoes a thermal treatment.

4. A method according to any one of claims 1 to 3 wherein after irradiation, the sample undergoes an additional optical treatment.

5. A method according to any one of claims 1 to 4 wherein after irradiation, the sample undergoes an additional treatment by sound waves.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/RU 98/00241

A. CLASSIFICATION OF SUBJECT MATTER

IPC^6: C03C 23/00, B44F 7/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC^6: C03C 23/00, 27/12, 17/00, C03B 33/00, B23K 26/00, B44F 7/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	RU 94021711 A1 (VASILIEV A.V. et al) 10 October 1995 (10.10.95)	1-5
A	SU 1620428 A1 (NII PRIKLADNYKH FIZICHESKIKH PROBLEM) 15 January 1991 (15.01.91)	1-5
A	SU 1818307 A1 (VLADIMIRSKY POLITEKHNICHESKY INSTITUT) 30 May 1993 (30.05.93)	1-5
A	DD 200251.0 A (AKADEMIE DER WISSENSCHAFTEN) 6 April 1983 (06.04.83)	1-5
A	GB 2226970 A (BRITISH AEROSPACE PUBLIK LIMITED COMPANY) 18 July 1990 (18.07.90)	1-5

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
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