

- 1 -

DESCRIPTION

Method and Device for Color Laser Marking

TECHNICAL FIELD

The present invention relates to a method and device for color laser marking, in particular, a method and device for color laser marking suitable for marking color patterns in different colors on the surface of the workpiece.

BACKGROUND ART

An example on the conventional technologies in this field is a method for marking on the surface of synthetic materials in Japanese Patent Laid-Open No. 56-144995. This technology includes coloring the surface of synthetic materials containing dyestuffs and silicon-containing inorganic compounds or surface of synthetic materials containing silicon-containing dyestuffs white, blue, violet, red and so on, by exposing the surface with a laser beam having the intensity of at least 1,000 kw/cm², measured on the surface.

Although the above conventional technology enables coloring white, blue, violet, red and so on, visible coloring may be also useful even if the color is not so clear. Further, coloring for marking on the surface of the workpiece, without the drastic modifications of conventional laser marking devices and without using dyestuffs not like

the above conventional technology, may be useful.

DISCLOSURE OF THE INVENTION

The present invention intends to provide a method and device for color laser marking suitable for marking color patterns in different colors on the surface of the workpiece, considering such a conventional technology and desires.

The method for color laser marking of the present invention is characterized by that the workpiece is a synthetic material made from organic and inorganic materials and patterns in different color is obtained by varying the received light intensity on the workpiece when irradiating the laser light. When the feature is limited by generated colors, the different colors are visually light grey, white, yellow and yellowish brown.

According to such a construction, when the workpiece is a synthetic material made from organic and inorganic compounds, the patterns is colored so that the patterns can be recognized to be light grey, white, yellow, and yellowish brown. However, the coloring itself has not been theoretically clarified. Moreover, the received light intensity for promoting the coloring has to be determined in view of the entire marking device construction, because the received light intensity depends on synthetic materials for the workpiece and specifications of the laser marking device.

The color laser marking device of the present invention is a device as an example using the above method for color laser marking. The first color laser marking device is characterized by that when the workpiece is a synthetic material made from organic and inorganic materials, a controller outputs laser irradiation intensity varying signals to at least one of laser irradiation intensity varying means comprising a laser oscillator, a Q switch of the laser oscillator, a mask, and a drive motor of a deflector for raster scan. A typical example of the mask is a transmission type liquid crystal mask.

The means for varying the received light intensity having the above construction comprises a controller for emitting commands to vary the received light intensity, and a laser irradiation intensity varying means which is connected with the controller and is controlled based on the commands. Thus, in this construction, patterns on the surface of the workpiece are automatically colored by adequately driving the laser irradiation intensity varying means with the controller.

The second color laser marking device of the present invention is characterized by that the workpiece is a synthetic material made from organic and inorganic materials; an optical system comprises at least one of a lens, prism, and mirror for deflection, collection, magnification, division, light attenuation, or mode change; and at least one optical system comprises a structure so

that at least one optical system of the lens, prism, and mirror is exchangeable with various optional parts, which power-separate or reflectively scatter the laser light so as to generate patterns in different colors.

The received light intensity varying means having the above construction comprises a changeable optical optional part. Thus, in this construction, patterns on the surface of the workpiece are colored by appropriately exchanging the optical optional part.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is an overall schematic diagram of a color laser marking device according to an embodiment of the present invention, and Fig. 2 is a table illustrating the test results of devices and methods according to this embodiment.

BEST MODE FOR CARRYING OUT THE INVENTION

The preferred embodiments will now be explained in detail on the method and device for color laser marking of the present invention according to the attached drawings.

As shown in Fig. 1, this example is a raster scan type laser marking device. This device has a YAG laser oscillator 1 with Q switch (hereinafter laser oscillator 1), collecting lenses 2, 4, and 5, a deflector 3 for raster scan, a transmission type liquid crystal mask 6, a deflector 7 for irradiating the optimum workpiece region, an objective lens 8, a workpiece 10, a controller 11, an external

terminal 12, a workpiece-feeder 14 driven by a motor 13, a location sensor 15 and the like. An example of the workpiece 10 in each embodiment is an epoxy resin, made by Toshiba Chemical CO., Low-Strain Epoxy Resin T-300, containing inorganic compounds, such as silicon dioxide and antimony trioxide, according to X-ray analysis.

This device will be described in detail. The deflector 3 for raster scan has a scan mirror 3Y and polygon mirror 3X, and the scan mirror 3Y deflects laser light P2 in Y direction on a transmission type liquid crystal mask 6 while being rotated with a motor 31. On the other hand, the polygon mirror 3X, rotated at a constant speed with a motor 32, deflects laser light P4 in X direction on the transmission type liquid crystal mask 6. The deflector 7 for irradiating the optimum workpiece region has a scan mirror 7X and moving table 7Y. The scan mirror 7X, rotated by a few angle at a time with a motor 71, deflects the transmitted light P6 in X direction on a marking area 9 of the workpiece 10 to maintain irradiation onto the optimum workpiece region. On the other hand, the moving table 7Y, moved with a motor 72, deflects the transmitted light P8 in Y direction on the marking area 9 of the workpiece 10 to maintain irradiation onto the optimum workpiece region.

The controller 11 is electrically connected with the transmission liquid crystal mask 6 through a line S1, the motor 32 through a line S2, the laser oscillator 1 through a line S3, the motor 31 through a line S4, the motor 71

through a line S5, the motor 72 through a line S6, the location sensor 15 through a line S71, the motor 13 through a line S72, the external terminal 12 through a line S8, respectively.

Further, the controller 11 synchronously drives or controls on-off control action of laser generation and intensity of output light of the laser oscillator 1, the raster scan speed of the deflector 3 for raster scan, the deflection movement of the deflector 7 for irradiating the optimum workpiece region, the movement and suspension of the workpiece feeder 14, displaying and rewriting the image with the transmission liquid crystal mask 6, as well as the communication with the external terminal 12.

The operation of such construction will be explained. The laser light P1 from the laser oscillator 1 is collected with the collecting lens 2 and irradiated into the deflector 3 for raster scan. The laser light P1 from the deflector 3 for raster scan is then subject to raster irradiation on the displaying image face of the transmission type liquid crystal mask 6 through the collecting lens 5. The collecting lens 5 collects the transmitted light P6 containing image information on the transmission type liquid crystal mask 6 onto the deflector 7 for irradiating the optimum workpiece region. The laser light P9 from the deflector 7 for irradiating the optimum workpiece region is irradiated within the marking area 9 on the workpiece 10 to mark patterns of the above image on the surface of the

workpiece 10. After accomplishment of marking, the next workpiece 10 is transferred to the marking position by driving the workpiece feeder 14. Additionally explaining, this laser marking device previously divides the whole pattern into each divided pattern, which is displayed on the transmission type liquid crystal mask 6. The deflector 7 for irradiating the optimum workpiece region deflects the laser light P9 from each divided image so that each divided image forms the entire image.

In the main body of such a laser marking device, the laser oscillator 1 is Q-switching-controlled with the controller 11, enabling on-off control of the laser generation as well as the modification of the intensity and oscillating interval of the laser light. The controller 11 also controls the applying voltage of the transmission type liquid crystal 6, thus enables the modification of its transmittance. Further, the scanning speed of the deflector 3 of raster scan is controlled with the controller 11. Accordingly, all the units can change the intensity of the received light on the surface of the workpiece 10 based on the commands from the controller 11. In other words, the received light intensity on the surface of the workpiece 10 can be controlled with the controller and these units. And such control can be carried out only by modifying the program of conventional devices 11.

By the way, such modification of the received light intensity on the surface of the workpiece 10 can be carried

out not only automatically with the above controller 11 and the laser irradiation intensity varying means, but also manually and so on. That is, in the above laser marking device, collector lenses 2, 4, and 5 and objective lenses 8 having various reflective scattering ratios are prepared as optional parts, and the received light intensity can be modified by adequately exchanging thereof.

Concerning the laser marking device, since various laser marking devices having similar specifications are used, the above controller and laser irradiation intensity varying means such as lens should not be, of course, limitedly used. When using a controller, the laser oscillator is, for example, not limited to the above YAG laser oscillator with Q switch, YAG laser oscillators by CW oscillation can be also used. Further, at the present stage, other laser oscillators would have some disadvantages for the use as the laser marking device in efficient, operational and economical points of view. On the other hand, in the manual operation, there are laser marking devices, for example, merely having various lenses, prisms, and mirrors for deflection, magnification, division, mode modification and the like. In the present invention, such devices can also be used not only by reflective scattering but also by magnification, division, mode modification or the like in order to modify the received light intensity on the surface of the workpiece. Therefore, regardless of automatic or manual operation, and even by the combined use

thereof, the color laser marking device can be used as what can adequately change the received light intensity on the surface of the workpiece.

Moreover, in the main body of the above conventional laser marking device, an optical attenuator may be positively and optionally provided between the laser source and the laser workpiece. In such a way, the color on the workpiece can be changed by controlling the laser light intensity irradiated onto the workpiece. Examples of the light attenuator include frosted glasses, the combinations of a polarizer and analyzer, Pockels cell and the like. When using the combinations of the polarizer and analyzer, the laser light intensity can be varied by modifying the opposite angle between both elements. Further, when using the Pockels cell, an external electric control is available for the laser light intensity.

Fig. 2, showing the experimental results of the present invention, displays colors of patterns on the surface of the workpiece which are generated by combinations of some means as parameters varying received light intensity regardless by automatic or merely exchanging including manual change. In detail, as parameters, which represent laser irradiation intensity varying means modified and controlled with the controller, laser output, Q switch frequency, scanning line's number, transmittance of the transmission type liquid crystal mask, and rotation speed of the polygon mirror are described. On the other hand, as parameters varying

received light intensity, which is manually controlled, lens magnification and beam mode are described.

In each aforementioned parameter, the received light intensity on the surface of the workpiece increases when the laser output increases, when the Q switch frequency increases, when the transmittance increases, when the rotation speed of the polygon mirror decreases, when the scanning line's number increases, when the lens magnification decreases (the denominator increases in the table), or when the beam mode is single. In addition, the value of each parameter is determined as follows: The laser output is determined by the current control to the excitation lump with the controller, the scanning line's number by rotation speed control of the scan mirror with the controller, and the lens magnification by exchanging the objective lens into another one having a different magnification, respectively. Further, as the beam mode, a single, original circular beam is converted into a twined, vertical peanut-like shape by inserting the polarizing prism in the optical path. As the results, visual white and yellow colors are generated. In detail, generated color visually changes to yellowish brown, yellow, white, or light grey by turn with the increased receiving intensity.

By the way, it is practically significantly convenient if the above received light intensity can be represented by, for example, the laser irradiation density per unit time and unit area on the surface of the workpiece. However, in the

YAG laser oscillator with Q switch, the increased pulse interval causes an extremely high peak value, whereas the decreased peak value causes a narrowed pulse interval, both resulting in difficult observation. Further, as shown in parameters of Fig. 2, due to different specifications of laser marking devices and different threshold values on the generated colors based on different materials for the workpieces, it is difficult to evenly determine the laser irradiation density specifying the generated color for all the workpieces.

Therefore, practically, when the specifications of the main body of the laser marking device and the material of the workpiece are determined, for example, Q switch pulse density and Q switch frequency per unit time and unit area on the surface of the workpiece as the receiving intensity may be correlated with the generated colors. Since the Q switch pulse density and Q switch frequency can be experimentally and empirically determined, it is practical.

In the aforementioned embodiments, when the workpiece is a synthetic material made from organic and inorganic compounds, patterns in different colors can be obtained by varying the received light intensity at the laser light receiving portion on the surface of the workpiece. Moreover, coloring can be surely visible without drastic modification of conventional laser marking devices, and without using dyestuffs not like conventional technologies. Additional effects include; the same workpiece can be marked

with plural colors and different gradations; color change is available when the workpiece is exchanged; and soot hardly forms.

INDUSTRIAL APPLICABILITY

The present invention is useful as a method and device for color laser marking, which can color to be surely visible, without drastic modifications of conventional laser marking methods and devices, and without using dyestuffs.



THIS SHEET HAS BEEN
REPLACED

WHAT IS CLAIMED IS:

1. A color laser marking method, for marking color patterns by irradiating laser light on a surface of a workpiece, comprising: said workpiece being a synthetic material made from organic and inorganic materials, and patterns in different colors being obtained by varying the received light intensity on said workpiece, when irradiating said laser light.

2. A color laser marking method according to claim 1, wherein said different colors are visually light grey, white, yellow and yellowish brown.

3. A color laser marking device: comprising a laser oscillator, a mask in which laser light from the said laser oscillator is irradiated, and a controller; color patterns of the image of said mask being marked on the surface of said workpiece by irradiating the transmitted light from said mask with said controller: wherein when said workpiece is a synthetic material made from organic and inorganic materials, said controller outputs laser irradiation intensity varying signals to at least one of laser irradiation intensity varying means comprising said laser oscillator, a Q switch of said laser oscillator, said mask, and a drive motor of a deflector for raster scan.

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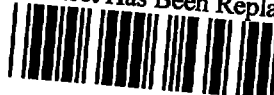


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4. A color laser marking device, comprising a laser oscillator, and an optical system and mask on which laser light from said laser oscillator is irradiated, for marking color patterns of the image of said mask on the surface of said workpiece by irradiating the transmitted light from said optical system and said mask on said surface of the workpiece: wherein said workpiece is a synthetic material made from organic and inorganic materials; said optical system comprises at least one of a lens, prism, and mirror for deflection, collection, magnification, division, light attenuation, or mode change; and at least one optical system comprises a structure so that at least one optical system of said lens, prism, and mirror is exchangeable with various optional parts, which power-separate or reflectively scatter said laser light so as to generate patterns in different colors.

5. A color laser marking method according to either of claim 3 or claim 4, wherein said mask is a transmission type liquid crystal mask.

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Method and Device for Color Laser Marking

ABSTRACT

The present invention provides a method and device for color laser marking for attaining visible coloring without drastic modification of conventional devices and without using dyestuffs. To this end, in a color laser marking method, a workpiece (10) is a synthetic material made from organic and inorganic materials and, when irradiating laser light, patterns in different colors can be obtained by varying the received light intensity on the workpiece (10). In addition, in a color laser marking device, when the workpiece (10) is a synthetic material made from organic and inorganic materials, a controller (11) outputs laser irradiation intensity varying signals to at least one of laser irradiation intensity varying means, such as a laser oscillator (1).

(Figure 1.)

FIG. 1

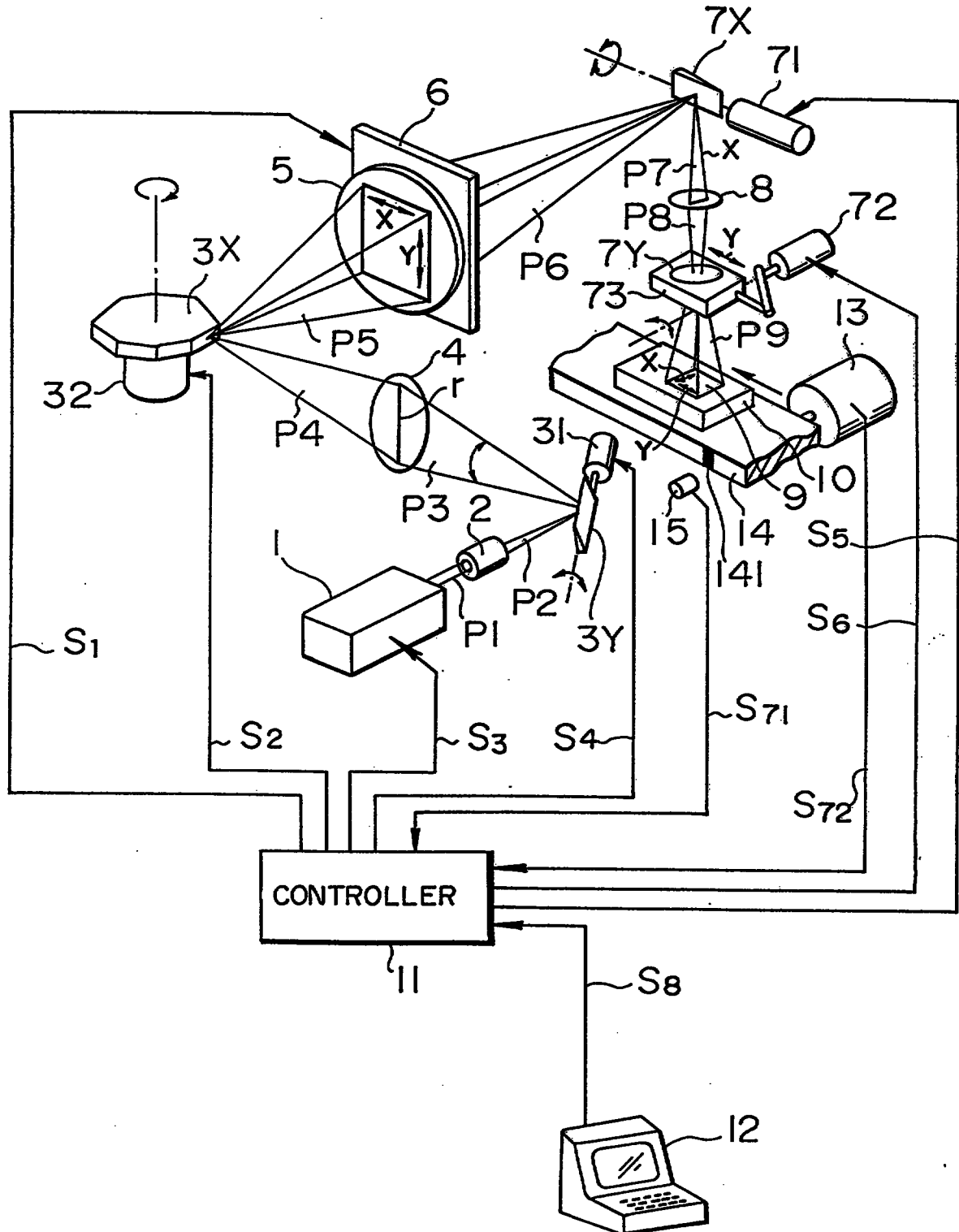


FIG. 2

LASER POWER	Q _{SW} FREQUENCY	LC TRANS- MITTANCE	POLYGON ROTATION SPEED	SCANNING LINE NUMBER	LENS MAGNIFI- CATION	BEAM MODE	GENERATED COLOR
120W	10 kHz	40 %	700rpm OR LESS	10 OR MORE	1 / 25	SINGLE	WHITE
120W	40kHz	50 %	550 rpm OR LESS	12 OR MORE	1 / 25	SINGLE	YELLOW
120W	10 kHz	40 %	850rpm OR LESS	⁶ OR MORE (x2)	1 / 37.5	TWIN	WHITE
120W	30 kHz	50 %	650 rpm OR LESS	⁷ OR MORE (x2)	1 / 37.5	TWIN	YELLOW



WHAT IS CLAIMED IS:

1. A color laser marking device, comprising a laser oscillator, and an optical system and mask on which laser light from said laser oscillator is irradiated, for marking color patterns of the image of said mask on the surface of said workpiece by irradiating the transmitted light from said optical system and said mask on said surface of the workpiece: wherein said workpiece is a synthetic material made from organic and inorganic materials; said optical system comprises at least one of a lens, prism, and mirror for deflection, collection, magnification, division, light attenuation, or mode change; and at least one optical system comprises a structure so that at least one optical system of said lens, prism, and mirror is exchangeable with various optional parts, which power-separate or reflectively scatter said laser light so as to generate patterns in different colors.

2. A color laser marking method according to claim 1, wherein said mask is a transmission type liquid crystal mask.

