Printing of Dye-Molecules on Polymeric Surfaces with the use of Laser Micro Printing Technique

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Abstract**—**A method for micro-patterning as well as immobilization of dyes upon polymer reactants with help of a low-strength seen laser for dye-excitation. Extracts from an aqueous medium containing the dye may be attached at any favored spot at the substrate definitely through exposing the area to laser mild. The range of beam can be controlled by the spot-length of immobilized dye, inside the variety of 16 - 150 microns. Micro printing is the manufacturing of recognizable patterns or characters in a published medium at a scale that calls for magnification to examine with the naked eye. To the naked eye, the text might also seem as a strong line. Attempts to breed by strategies of photocopy, picture scanning, or pantograph normally translate as a dotted or solid line, until the replica method can identify and recreate styles to such scale. Microprint is predominantly used as an anti-counterfeiting technique, as its inability to be without problems reproduced through virtual techniques. The immobilization technique is represented by micro-printing numerals, alphabets and patterns on polybutadiene reactants with Rhodamine (Rh6G) dye. Adsorption of laser-excited molecules within the polymer seems to be the mechanism for laser-printing method.

Keywords*-Laser, Micro-Printing, Laser Immobilization of Molecules, Micro-Patterning, Reticle*

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I. INTRODUCTION

In the last decade, micro-printing is typically stated while discussing anti-counterfeiting techniques on items of fee. Currencies, IDs and checks are a few examples of using very small textual content, too small for the naked eye, for authenticity text or symbols of such small size, normally inside the micron range, are extremely tough to reproduce as it should be consequently, using micro-printing is a viable approach for anti-counterfeiting an object and confirming its genuineness. Micro-printing proves useful in many areas, on many surfaces, for multiple functions. From serial numbers to bar codes, micro-printing is a ubiquitous necessity in our society as a result, there are many strategies pronounced. Micro-etching and micro-deposition of strong materials, like metals and polymers, using ultrashort pulses of UV laser radiation had been seemed to gain microstructures of dots, strains and complicated multilevel styles with less decision. The high-resolution micro-printing techniques have demonstrated to be useful for the composition of digital devices and organic digital devices. Lasers produces high definition micron diffractive patterns that may be present on planar and cylindrical reactants which includes optical fibers. it's been identified that laser prompted ahead switch (lift) is suitable for patterning microarrays for proteins in addition to antigens without losing any antigenic reactivity or diagnostic houses [2] on this manner, a pulsed laser is used to result in the transfer of cloth from a laser-obvious source movie onto a nearly placed substrate.

As the laser pulses pass through the film and are absorbed with the aid of the receptor substrate, cloth is taken from the source and deposited on the substrate. Translation of the reactants and/or scanning the beam help in the formation of complex styles [4]. The elevate method is straightforward and can be used for many strong movie materials inclusive of copper and aluminum [8].This is offered for its application for printing micro-texts and styles and for bar-coding even though it can even have a ability for immobilizing dye-labeled biomolecules on polymer surfaces for bio sensing-associated applications.

II. MATERIALS & EXPERIMENTAL SECTION

Rhodamine B is tunable around 610 nm when used as a laser dye. Its luminescence quantum yield is 0.65 in basic ethanol,0.49 in ethanol, 1.0, and 0.68 in 94% ethanol. The fluorescence yield is temperature dependent. The solubility of rhodamine B in water is ~15 g/L. However, the solubility in acetic acid solution (30 vol.%) is ~400 g/L. Tap water decomposes rhodamine B. Rhodamine B solutions adsorb to plastics and kept in glass. The powder form Rhodamine B is diluted in distilled water to a attention of one mg/ml. A 2.5% by weight answer of polybutadiene rubber in cyclohexane answer is spin lined at 3000 rpm on microscope glass reactants the usage of spin coating system.

The 610 nm argon-ion laser, with most output energy of fifty mW and beam diameter of 0.45 mm, used for the immobilization of Rh B molecules and micro-printing process become synthetic to immobilize RhB molecules and fabricate

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patterns over a bigger location of polybutadiene lined glass reactants, the laser beam changed into expanded to two mm diameter the use of a beam expander. The 22 - 28 mm diameter and 1.2 - 2.10 mm thick reticles with huge range of styles and sizes were used as mask for micro printing. The patterns on these masks (together with alphabets and numerals) have opaque traces revealed on transparent glass surface with a line thickness of approximately 26 µm. The schematic setup used for immobilization of dye molecules from aqueous section and laser micro-printing of pre-patterned shapes the use of contact-reticles on polybutadiene-lined slides is proven in determine 1. In determine 1(a), a small drop of dye-solution is sandwiched among a skinny cowl-glass substrate (0.2 mm thickness) and a fashionable glass slide, the quilt-glass in addition to the glass-slide is covered with polybutadiene film on the side that is in contact with dye-solution. Hydrophobic nature of the polymer film additionally continues the dye-solution trapped among the duvet-glass and the glass-slide without flowing away because of capillary movement. Thickness of the sandwiched dye-answer is generally 1.1 mm. The reticle/mask with the pre-etched pattern is loosely located on pinnacle of the quilt-glass. An opportunity set-up for micro printing with the aid of this method is proven in parent 1(b). This makes use of a bigger mobile full of the answer of the dye to be immobilized. In this case, the substrate is located near to the wall, inside the mobile with the polymer-coated facet facing the incident laser. The reticle/masks is saved adhered outdoor the cellular-wall as shown and as this set-up uses large amount of dye-answer, it allows printing on a couple of reactants without the want for replenishing the answer as is finished for set-up 1(a). The optical micrographs of the numerous metric and multi-gauge contact reticles used for patterning and inactivation of RhB molecules on polybutadiene coated reactants as in discern 2.

III. RESULTS & DIALOGUE

This section describes the effects of visible-light caused micro-printing by embedding a dye in the polymer floor. A summary of micro-printing using numerals, alphabets and different geometrical styles is given underneath the stability of micro-published patterns under good conditions is likewise defined by use of the continuous-wave 610 nm laser with 40 mW electricity for micro printing with the aid of this method and it is observed that laser excitation of RhB solution in touch with polymer reactant consequences in adsorbed deposit of the dye at the substrate, therefore, as the dye-solution in touch with the substrate is uncovered through the reticle, the pattern formed on the polymer film is an exact duplicate of the transparent areas of the reticle/mask depending at the depth of the writing laser, it takes several minutes for the published sample at the polymer to come to be visible. In widespread, the rate at which the dye receives implanted in the substrate rises with the depth of laser light. Outcomes of micro printing on the polymer substrate demonstrated in figure 3 for a laser exposure time of 20 mins. Figures 3(a)-(c) are patterns created the usage of multi-reticle (a), radial strains (b), and numeral "60" (c). In each case, the width of the road is ready 25 microns. In determine three (d), the increment among divisions is zero. Half" (one hundred twenty-five micron) and numeral "3" has a width of 250 microns. Parent 3(e) suggests a sample of a metric line with 100 micron increments. The letter "m" extends a width of 3 markings indicating a 300-micron width. figure three(f) is pattern created through reticle with double-sided metric traces, in 0.01" increments (pinnacle) and in 0.1 mm increments (bottom).

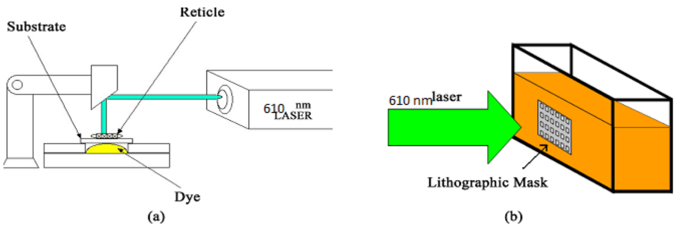
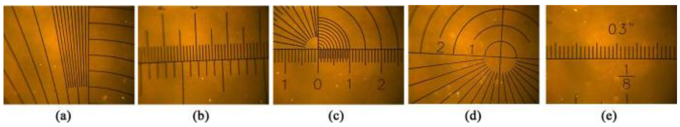


Figure 1.Schematic experimental set-up for laser micro-printing and immobilization of RhB dye and other biomolecules on polymer substrates (a). The change set-up the usage of aqueous cell (b) packed with dye-answer.



Discern 2.Optical micrographs of some of the metric and multi-gauge touch reticles used for patterning and immobilization of RhB molecules on polybutadiene covered glass slide.

Figure three(g)shows a pattern of radial strains indicating 10 degrees' attitude in 0.1 diploma increments, and figure three(h) is a sample of lines with zero. Half" increments. The numeral "2" extends a width of a hundred ninety microns. After laser exposure, the polymer reactant is washed through dipping in water to get rid of the excess dye-solution sticking to it after which dried before observing with an optical microscope.

The reticles used are designed in such a manner that the traces in the patterned surfaces are opaque and the ultimate regions are transparent to the 488 nm laser light. As proven in parent three, the styles are the direct copy of the reticles used, whereby, the dye molecules are immobilized most effective into the exposed areas of the polybutadiene surface that is, the lines, letters, figures and dots are the areas in which the dye molecules aren't attached to the reactants.

Its miles found that the micro-revealed samples can be stored for numerous weeks in air without any noticeable de-gradation. As proven in parent 4(a), there is no substantive degradation even though the samples are stored submerged in water for some hours. This degradation under water can in addition be decreased by covering the dye-embedded vicinity with scotch tape (discern four (b)) and recoating it with any other layer of polymer skinny movie (figure 4(c)). Parent 4(d) and parent four(e) show the patterns after the spin-coated sample of (c) is immersed in water for twenty-four hours and for 15 days respectively. determine four(f) suggests the pattern if it's miles immersed in water for 24 hours without the second one shielding coat of polybutadiene thin film due to the fact that any unattached dye-residue can be without difficulty washed away with water in a few seconds, we believe that the dye receives embedded (adsorbed) deeper within the polymer movie because of dye-excitation with 488 nm laser mild. The technique of micro-printing accordingly entails enhancement of the adsorption method due to mild excitation however, if kept submerged in water for several hours, the micro-printed sample fades gradually. This once more indicates that the dye is physically adsorbed without forming any sturdy covalent bond with the polymer.

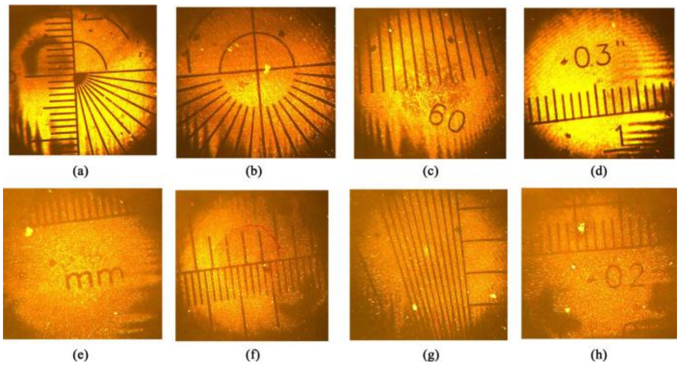


Figure 3. Illustration of multiple Rh6G patterns created by laser immobilization of Rh6G molecules through multiple reticles into the exposed regions of the PBR surfaces for 20 minutes.

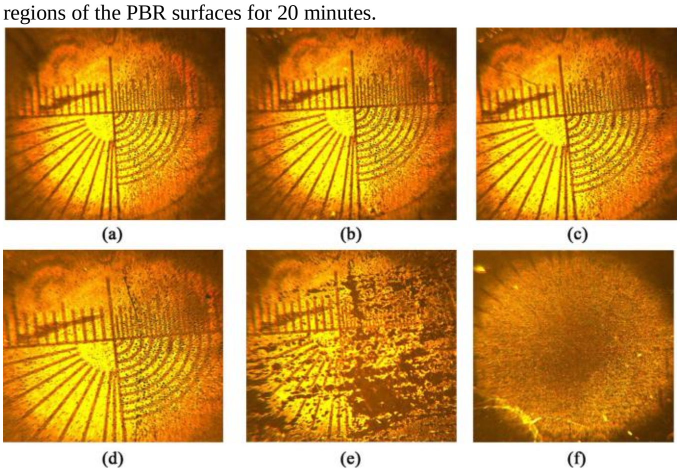


Figure 4. Impact on dye-immobilized samples stored in water before and after overlaying the patterns with scotch tape and a spin-lined layer of polybutadiene.

CONCLUSION

In end, a way for laser micro-printing and inactivation of dye molecules on a polymer movie lined substrate is described. The method is demonstrated with laser excited RhB dye and a low-strength 610 nm lasers but can work with other laser-dyes and corresponding visible lasers to excite them. We've also shown the technique to paintings with NBD dye excited with 610 nm laser despite the fact that the variety of appropriate polymer reactants stays to be investigated, whilst stored in ambient situations, the patterns shaped did no longer display great degradation for several days. The patterned reactants can also be left in water for some hours without great degradation and balance below water can be stepped forward by covering it with a scotch tape and recoating with polymer. The method demonstrated here has a capacity for instant, smooth and inexpensive micro-printing of lines, dots, letters, symbols, and different complicated styles on polymer reactants and in all likelihood for controlled inactivation and patterning of dye-classified biomolecules on polymer reactants for bio sensing utility.

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