POSTER PRESENTATIONS

NOTE:

Each poster is encoded with the Poster code (P), the session (A or B) and the number of the posters location.

Example:
PB-28 is for Poster, session B at location 28.

TUESDAY 17 JUNE

POSTER SESSION A

PA-1

DEVELOPMENT OF 2D/3D MICROSTRUCTURING TECHNIQUES USING NS PULSED UV LASERS

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The need for development of manufacturing techniques based in laser micromachining has led to the design of specific micromanufacturing laser based workstations for each process of interest (most of them until now strictly 2D) and an important progress from the manufacturing point of view has been completed allowing the development of fully 3D microstructuring applications. In the present work, some results on 2D/3D micromanufacturing developments obtained by a specially designed dual excimer-DPSS working in the ns pulse width range microfabrication workstation are presented. The results are considered as specially important from the point of view of the versatility and accuracy of the advanced positioning system (six degrees of freedom, 40 µm SoC) used to structure conceptually difficult typical components.

PA-2

FEMTOSECOND LASER ASSISTED ETCHING OF BOROSILICATE GLASSES

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Femtosecond laser assisted etching is a technique for internal three-dimensional removal processing of transparent materials. In the present study, we have applied this technique for the fabrication of microchannels in borosilicate glasses. We used aqueous KOH solution as an etchant, constructed an in-situ monitoring system of etching process. An etching selectivity of several hundreds was obtained; this value is higher than the values for glasses when aqueous HF solution was used as an etchant.

PA-3

THE VACUUM PRESSURE EFFECT ON LASER DRILLED PMMA

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The vacuum pressure effect on laser drilled PMMA E. Akman, L. Candan, T. Canel, A. Demir, E. Kacar Laser Technologies Research and Application Center Kocaeli University Umuttepe Campus 41380 Kocaeli/Turkey In this study, we report the results of the micro drilling application of PMMA polymers using nanosecond laser in vacuum and atmosphere environment. And also drilling studies are performed using different wavelengths (1064, 532, 355 nm) of the Nd:YAG laser.

PA-4

PARTIAL GROWTH OF CRACK AND CROSS SCRIBE IN LASER SCRIBING OF GLASS

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After an initial crack is formed, and the crack of laser scribing is propagated at the cooling area due to the tensile stress, but the compressed area below the cooling area prevents the vertical growth of the crack. In this study, both of the phenomena in which the crack grown deeply in the laser shielded area and that of the cross scribe without the initial crack are discussed based on three-dimensional thermal elasticity analysis. As a result, the deep crack grows, because inner compressive stress field decreases under the shielded area, and two kinds of forms were found in the propagation of the cross scribe.

PA-5

UV LASER-INDUCE HIGH RESOLUTION CLEAVING OF SI WAFERS FOR MICRO-NANO DEVICES CHARACTERIZATION

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Silicon based mass production technology at micro-nano scale is increasing the number of devices every year to enhance the functionality of micro-nano devices for a broad field of applications. Laser micromachining technology systems have been widely applied in the last twenty years in micro-nano fabrication processes. In this work we present a high resolution method to reach wafer submicron domains by using a Nd:YVO4 laser emitting pulsed UV radiation at 355 nm in ns pulse regime for Si wafer cleaving without human manual intervention in order to analyze both: devices characterization and control the fabrication processes.

PA-6

LASER TRANSMISSION MICRO-JOINING OF DISSIMILAR MATERIALS USING FIBER LASER

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Laser transmission micro-joining is a promising technique for sub-millimeter joining of dissimilar materials. It avoids subjecting the complete system to high temperature by providing localized heating and has the potential for applications such as biomedical implants and their encapsulation process. In this work, Yb-doped fiber laser operating at wavelength of 1100nm was used for laser joining of four such systems, viz. Polyimide/Nitinol, PEEK/ Nitinol, Polyimide/Chromium and PEEK/Chromium. Results from mechanical tensile tests, bond surface micrographs and XPS can be potentially used in optimization of design process of devices that utilize these materials.

PA-7

A LASER INDUCED MICROMACHINING HAS MANY APPLICATIONS IN THE FIELD OF BIOMEDICAL SCIENCE AND IN MICROMACHINING FOR MICROELECTRONICS, AND MICROELECTROMECHANICAL SYSTEMS

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Periodic microstructures have been created using the Nd: YVO4 laser at a wavelength of 1064nm and pulse width of 14 nanoseconds. Periodic surface structures or patterns were created on stainless steel using different power, different repetition rates and for different machining time. Experiments were done at various power levels preliminary results show that area of machining can be increased by changing the power of machining. Depth of the machining can be increased by increasing the number of pulses (time) hitting the surface for machining and the size of the features created on the surface are near to the wavelength of the laser used for machining in our case wavelength is 1064nm.

PA-8

LASER INDUCED FORWARD TRANSFER (LIFT) IS A SIMPLE DIRECT WRITE TECHNIQUE WHICH OFFERS THE ABILITY TO MAKE SURFACE MICROPATTERNING BY LOCALIZED DEPOSITION OF MATERIAL

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Laser Induced Forward Transfer (LIFT) is a simple direct write technique which offers the ability to make surface micropatterning by localized deposition of material [1]. The excellent biocompatibility and resistance to corrosion of gold provides a number of applications of gold patterning in medical devices .The laser beam was focused on the gold thin film (donor) through a optically transparent glass substrate. Our work deals with deposition of patterns of thin gold film on the glass substrate by Nd:YVO4 laser having central wavelength of 1064nm and pulse width of 14ns. Preliminary results suggest that we can successfully transfer patterns with proper focusing and by varying power and repetition rate on the donor film.

PA-9

LASER-PROCESSING OF ULTRA-THIN METAL FILMS FOR SURFACE-PLASMON RELATED PHENOMENA USING DIMLPA

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Diffraction mask-projection laser ablation (DiMPLA) using excimer laser radiation is applied to generate sub-micron patterns out of thin metal films on transparent substrates. The latter patterns exhibit surface-plasmon related phenomena.

PA-10

SURFACE MODIFICATION OF SILICON WITH NANOSECOND LASER PULSES IN WATER

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This paper presents the observation of laser-induced surface modification of silicon in water at different applied laser fluence levels and laser shot numbers. The experimental results are conducted using 15 nanosecond pulsed laser irradiation at 532 nm. The silicon surface morphology of the irradiated spots has an appearance as one can see in porous formation

PA-11

FEMTOSECOND LASER STAINLESS STEEL MICRO-PROCESSING

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Micro-machining experiments using femtosecond laser pulses were performed in air on stainless steel. A CLARK CPA2101 laser (linearly polarized, wavelength 775 nm, pulse duration 200 fs, pulse repetition 2 kHz rate) was used. The target surface was irradiated at normal incidence at fluences <7 J/cm2. Ablated pattern characteristics as a function of target movement direction relative to the laser beam polarization direction and fluence have been studied. Periodic structures within the ablated pattern have occurred at certain fluence values.

PA-12

FEMTOSECOND LASER PATTERNING BY TWO-PHOTON POLYMERIZATION

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We have demonstrated femtosecond laser patterning with submicron grating structures by two-photon polymerization technique. Maskless femtosecond laser patterning can provide a potential solution for future applications.

PA-13

FEMTOSECOND LASER INDUCED PERIODIC SURFACE STRUCTURES ON ZNO THIN FILMS

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Periodic surface structures were induced on ZnO thin film when irradiated with 180 femtosecond laser pulses at 775 nm wavelength and laser fluence near the ablation threshold. SEM images reveal ripples with 150 nm spacing, much below the laser wavelength. Clear and uniform grooves are created along the laser scanning direction, perpendicular to the laser polarisation. Aspect ratio of ripples dependence on scanning speed, laser energy and polarization was investigated. Such microprocessing method suggests a possible technique to produce high density optical gratings.

PA-14

BACKSIDE WET ETCHING WITH ULTRASHORT UV-LASER PULSES FOR GRATING ENGRAVING IN CRYSTALLINE MATERIALS

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The etching of sub-micron relief gratings in crystalline substrates by combining ultrashort laser pulses with laser-induced backside wet etching (LIBWE) are shown and discussed. New results on LIBWE of optical crystals (sapphire, CaF2, MgF2) - extending recent findings [1] - by using liquid organic absorbers and applying long coherence length 150 ps laser pulses at the wavelengths of 213 nm and 266 nm will be presented. The etching of high quality relief gratings in the above materials, of typical period 500 nm approximately, or shorter, will be shown. [1] S. Pissadakis, R. Böhme, K. Zimmer, Opt. Express 15, pp. 1428-33 (2007).

PA-15

THE RESEARCH ON LASER MICROPROCESSING TECHNOLOGY

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Under the support of China's National Science Foundation and Beijing government several projects involving laser microprocessing have been carried out in recent years. The great progress has been made in the field of laser micro- processing with excimer laser and micro fabrication. Based on the principle of excimer laser micromachining, a micromachining system has been developed. The 50~500□m diameter micro-gears have been made using polymers and ceramics. Meanwhile the excimer laser has been to manufacture micro fluid biochip. Besides this micro fabrication using laser microsintering powder material has been investigated.4-5micro metallic particles were composed to form a thin wall.

PA-16

LASER MICROMACHINING OF FATIGUE MICRONOTCHES IN TITANIUM ALLOY

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A precision laser micromachining method to fabricate micronotches for characterization of mechanical properties of various materials has been explored. Current technique for crack notch fabrication is based on electric discharge method (EDM). However, the pre-notches fabricated by EDM method produces much larger tip radius and generate heat affected zone. The stress and strain amplitudes at the tip of laser produced micronotches would be significantly greater than for EDM prepared notches. A diode pumped solid state laser was used for fabrication of micronotches. Laser produced micronotches were examined under a scanning electron microscope for determination of physical dimensions and quality.

PA-17

LASER FABRICATION OF METALLIC MICROCHANNELS AND EVALUATION FOR THE USE OF WICK-STRUCTURE OF MICRO HEAT PIPES

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Laser micromachining of microgrooves for the application to micro heat pipe. Fabrication and evaluation are to be presented.

PA-18

A LASER INDUCED MICRO DRILLING HAS MANY APPLICATIONS IN THE FIELD OF ELECTRONICS AND BIOMEDICAL SCIENCE

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A laser induced micro drilling has many applications in the field of electronics and biomedical science. A drilling method has been experimented and studied by varying the medium between the focusing lens and machining surface.Intially air was used as medium for machining and the results obtained was compared with machining done with few millimeter of water on the surface of substrate and also with few millimeter thick quartz plate on the surface of substrate keeping all the machining parameters constant in all the three cases.

PA-19

EFFECTS OF THE LASER WAVELENGTH ON THE ND: YAG LASER DRILLING PROCESSES OF THE CERAMIC PLATES

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Effects of the laser wavelength on the Nd:YAG laser drilling processes of the ceramic plates E. Kacar, A. Demir, E. Akman, P. Demir, M. Mutlu Laser Technologies Research and Application Center Kocaeli University Umuttepe Campus 41380 Kocaeli/Turkey In this study, we report the results of the micro drilling application of ceramic using nanosecond laser for different wavelength (1064, 532, 355 nm) in vacuum and atmosphere environment.

PA-20

OPTIMIZING PARAMETERS FOR DEEP ULTRASHORT PULSE LASER MICRODRILLING WITH THE ASSIST GAS APPLICATION

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We use the femtosecond laser radiation for precision micro drilling of shape-memory alloy ferule (SMA). To increase the velocity for production purpose and in the same time to improve the quality of treatment we studied the influence of some assist inert gazes. The results show the significant improvement of the speed of drilling with nitrogen for trepanning mode: up to 3.5 times faster for the diameters from 100 to 120 microns for 2 mm long SMA ferules. The parameters of the assist gas setup should be specially chosen to remove the ejected particles and vapors during the deep drilling procedure

PA-21

DEEP HOLE MICRODRILLING WITH FREQUENCY-DOUBLED FEMTOSECOND LASER PULSES.

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We use a femtosecond pulse laser for drilling of precision diameter micro channels in metal ferules made from super-elastic mono-crystalline shape memory alloy (SMA) for development of the fiber optics connector . We studied the drilling speed improvement with the second harmonics laser radiation (387.5 nm) in comparison with the fundamental 775 nm wavelength for 120 femtosecond pulse laser. It is shown that for drilling depth larger than 1.5 mm, the pulse energy needed for equal diameter and drilling speed could be at least a factor 2.5 smaller when using the second harmonic for trepanning procedure.

PA-22

OPTIMIZING DRILLING STRATEGIES FOR MICROMACHINING OF ALUMINA SUBSTRATES USING FEMTOSECOND LASER PULSES

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In this work interaction of high intensity (GW/cm2) infrared femtosecond laser pulses with 250 µm thick ceramic alumina targets is studied. We apply the pulsed laser helical drilling technique to investigate aspect ratii and the dynamics of conicity hole-through formation versus energy density and drilling depth. On this basis, optimum drilling parameters are found thus demonstrating high-aspect-ratio machining with micron-scale accuracy and negligible heat affected zone.

PA-23

LIBS ASSISTED FEMTOSECOND LASER STRIPPING OF POLYMER COATED COPPER WIRES FOR AN IMPLANTABLE MICROSENSOR

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Implantable microdevices have strict requirements to miniaturization. When multiple signals are to be transferred to and from the microsensor, a ribbon cable with well defined pitch of the conductors is suitable. We have used infrared femtosecond pulses to strip off polymer insulation 18 µm thick coating a micro ribbon cable consisting of 13 copper conductors in parallel with 45 µm diameter in order to achieve small areas where the cable could be bonded to the microsystem. We are developing a fs-LIBS setup to optimize the ongoing process by selecting the scanning speed and laser fluence to avoid damage in the conductors.

PA-24

OPTICAL EXTINCTION FOR DETERMINING SIZE DISTRIBUTION OF GOLD NANOPARTICLES FABRICATED BY ULTRASHORT PULSED LASER ABLATION

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We present an effective optical extinction method to determine a mix of several monomodal size distributions of gold nanoparticles in water solution obtained by femtosecond laser ablation. We show that optical extinction method is extremely sensitive to distinguish slightly different size contributions for fitting the experimental spectra.

PA-25

SYNTHESIS OF COLLOIDAL BBO NANOPARTICLES BY FEMTOSECONDLASER ABLATION OF IMMERSED BULK CRYSTALS

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Non linear crystals have paramount interest in the field of laser applications. In the last years, a big amount of new effects and materials have seen the light. In this work, we succeed in producing nanoparticles from BBO bulk crystals immersed in different liquid media by irradiation with infrared femtosecond laser pulses. Phase matching experiments will be carried out with nanopowder consisting of nanoparticles with different size distributions. This technique applied to crystal solids opens the possibility to generate nanopowders with sizes on demand for nonlinear optical applications.

PA-26

GOLD NANOPARTICLES AND NANORODS ENHANCED LASER NANO-ABLATION

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When an electromagnetic wave hits metallic nanostructures, it is absorbed and reemitted in near field with enhanced intensity. This amplification is caused by the nanostructures' surface plasmon resonance, and can be used to perform nano-ablation of the substrate. In this study, the field enhancement was determined to be 3,0 ± 1,0 and 2,4 ± 0,6 for gold nanoparticles of respectively 60 nm and 100 nm deposited on Si substrate, when a Ti-Sapphire femtosecond pulse laser at 800 nm wavelength was used. Nanorods with a width of 30 nm and various lengths are also being investigated.

PA-27

SELF-ASSEMBLY OF NANOHILLS IN SIXGE1-X/SI HETEROEPITAXIAL STRUCTURE BY LASER RADIATION

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For the first time observed self-assembling nanohills induced by irradiation of nanosecond Nd:YAG laser pulses in the Si0.7Ge0.3/Si heteroepitaxial structures with initially uniform distribution of Ge atoms over the top layer is reported. Formation of the Ge-rich phase is explained by localization of Ge atoms drifting toward the irradiated surface under the thermal gradient due to strong absorption of the laser radiation. The Photoluminescence band at 700-800 nm the maximum of which shifting to shorter wavelengths with the increase of the intensity of laser

radiation and appearance of the 300 cm-1 Ge-Ge vibration band in micro-Raman spectra are explained by the quantum confinement effect in nanohills.

PA-28

FABRICATION OF LARGE SIZE 4-LEVEL PHASE TYPE DOE USING LASER DIRECT WRITE LITHOGRAPHY SYSTEM

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We fabricated the 4-level phase type of diffractive optical element (DOE) using the laser direct write lithography system. Although it is difficult to draw to a large-sized substrate with electron-beam lithography system, since the laser direct write lithography system makes it possible, production of the large DOE is expected. Furthermore, 2 and 4 levels phase-type DOEs were produced by dry etching processing to the substrate, and comparison of the diffraction efficiency of the 2-level and the 4-level of phase-type DOE was discussed.

PA-29

STRUCTURAL CHANGES INDUCED BY FEMTOSECOND LASER PULSES ON 4H-SIC SINGLE CRYSTAL: STUDIES UTILIZING TRANSMISSION ELECTRON MICROSCOPY

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We studied the microstructures of femtosecond laser-induced ripples formed on 4H-SiC single crystals by using cross-sectional transmission electron microscopy. Particular attention was paid to the crystal structure underlying fine and coarse ripples. TEM analyses showed that a continuous amorphous layer approximately 10 to 50 nm thick covers the topmost region of ripples. These results suggest that the fundamental surface deformation process is common for the entire region of fine and coarse ripples, even though the factors that determine their periods are different.

PA-30

DEVELOPMENT OF A LASER WELDING APPARATUS FOR WELDING ALONG THE LINE OF INTERSECTION OF INNER STRAPS FOR A PWR SPACER GRID ASSEMBLY AND ITS APPLICATION

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A spacer grid assembly, which is an interconnected array of slotted grid straps normally joined to each strap by a small nugget welded at the ends of their line of intersections, is one of the core structural components of the nuclear fuel assemblies of a Pressurized light Water Reactor (PWR) as shown in figure 1(a). The spacer grid assembly is structurally required to have enough crush strength under lateral loads so that the nuclear fuel rods are maintained in a coolable geometry, and that control rods are able to be inserted. The capacity of a spacer grid assembly to resist lateral loads is usually characterized in terms of its dynamic and static crush strengths. Based on

that the crush strengths of a spacer grid assembly are known to proportional to the weld length of intersections of the slotted grid strapsas shown in figure 3, a laser welding apparatus which enable to weld along the line of intersection of inner straps for a PWR spacer grid assembly was developed in this study as shown in figure 2. And also, the crush strength test and analysis of the spacer grid assemblies welded by the developed laser welding apparatus was carried out to confirm the effect of crush strength enhancement.

THURSDAY 19 JUNE

POSTER SESSION B

PB-1

OBSERVATION OF INITIAL STAGE OF FILM FORMATION BY THE PLD METHOD ON THE SI(111)-7×7 SURFACE

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We have observed the initial stage of β-FeSi2 film formation onto Si surface by the pulsed laser deposition (PLD) method using different target intending to obtain the information of Si/β-FeSi2 interface. We used the STM for the observation. For the PLD experiment, Q-switched 2ω-YAG laser, Fe target and ε-FeSi target were used. As a result, it was found that FeSi cluster were adsorbed in the case with ε-FeSi target, whereas mainly the single atom with the Fe target.We think the main reason of the difference of film quality by different targets is due to the difference of the sites and species which initially adsorb on the Si surface.

PB-2

SIMULATION OF LASER FORMING (STUDY ON CAUSED STRAIN DURING CONVEX BENDING)

K. Hosokawa, C. Tsuchimoto, M. Saeki; Chubu University, Japan

In the laser forming of a metal plate, the bending process is caused by the thermal stresses which are produced in the plate by the laser irradiation. In the present study, to analyze the laser forming, the finite element method (FEM: LS-DYNA) is used and the laser beam is modeled by the Gaussian distribution, and then the bending deformation of the plate is estimated by the FEM. In the numerical examples, the distribution of the strain in the metal plate is clarified when the convex shape is generated by the laser forming.

PB-3

LASER ABLATION OF SILICON IN WATER WITH NANOSECOND PULSES

N. Mansour and R . Karimzadeh; Department of Physics Shahid Beheshti University, Tehran, Iran

We study laser ablation of silicon in water using nanosecond pulses. The experimental results are conducted using 15 nanosecond pulsed laser irradiation at 532 nm. Compared to the ablation rate in air, an approximately twofold improvement in the rate is found for applied laser irradiance range of 4 - 11 J/cm2 . Silicon ablation depth are measured at different applied laser fluences and shot numbers under water confinement

PB-4

SHAPED ULTRA-SHORT LIGHT PULSES FOR MATERIALS PROCESSING

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A closed loop setup for adaptive temporal pulse shaping in the fs- to ps domain, based on a feedback evolutionary algorithm in combination with a spatial light modulator and an optical phase contrast microscope, was developed in order to investigate the control over the energy deposition and material relaxation, in the perspective of generating optical structures with arbitrary refractive index profiles. This flexibility exhibits strong technological potential and is particularly interesting in presence of strong aberrations. As a main result is shown that temporal pulse shaping allows for controlling the length and the contrast of the laser-induced refractive index structure.

PB-5

EFFECTS OF LIQUID LAYER ON LASER ABLATION STUDIED BY VISUALIZATION OF TRANSIENT STRESS

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A stress distribution inside a solid induced by a high power laser pulse under liquid has been observed by photoelasticity method with nanosecond time resolution. Magnitude of laser-induced stress can be estimated from the time-resolved photoelasticity images. The stress is one order of magnitude larger in liquid than without liquid. When the liquid layer is thin, its effect weakens. Film thickness of 1mm seems to be enough to induce the effect. Theoretical approach to evaluate the magnitude of the stress from the photoelasticity images have been carried out by reconstructing images using a simulation method based on finite-element method.

PB-6

DYNAMICS OF ONE LASER PULSE SURFACE NANOFOAMING OF BIOPOLYMERS

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Self standing films of the biopolymers gelatine, collagen, chitosan, irradiated with single ns and fs laser pulse easily yield on their surface, a nanofoam layer, formed by a cavitation and bubble growth mechanism [1-2]. The laser foam has interesting properties [3-4] (Fig.1) that challenge the molecular features of the natural extracellular matrix and which make them good candidates for artificial matrix fabrication (nanoscopic fibers, large availability of cell adhesion sites, permeability to fluids due to open cell structure). As part of the mechanistic study, the dynamics of the process [5] has been measured in the ns timescale by recording the optical transmission of the films at 632 nm during and after the foaming laser pulse. A rapid drop 100□0% taking place within the first 100 ns supports the cavitation mechanism as described by the previous negative pressure wave model [6]. As modelled a strong pressure rise (~several thousands of bar) first takes place in the absorption volume due to pressure confinement and finite sound velocity, and then upon relaxation after some delay equal to the pressure transit time gives rise to a rarefaction wave (negative pressure) in which nucleation and bubble growth are very fast.

PB-7

LASER SINTERING OF ULTRA HIGH TEMPERATURE CERAMIC (ZRB2)

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Results about a new approach using laser system for sintering of ultra high temperature ceramics (UHTC) of zirconium diboride (ZrB2) are presented. Experiments using single pulsed laser and a concentric dual laser system were carried out. Scanning electron microscopy images showed that the concentric dual laser sintered layer using ~2 µm particle size of ZrB2 had smooth surface morphology. X-ray diffraction results revealed that the sintered layer primarily retained the crystalline phases as the starting powder. Microsintering was used to generate thin films and localized depositions for repairs of ultra high temperature materials applications.

PB-8

COMPARISON OF LASER ANNEALING ON REFRACTIVE INDICES OF RF SPUTTERED AMORPHOUS SIC AND SIN THIN FILMS.

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Comparison of Laser annealing on refractive indices of rf sputtered amorphous SiC and SiN thin films.

PB-9

NANOSTRUCTURE FORMATION FROM LASER-MICROWAVE HYBRID PROCESSING OF ZIRCONIUM DIBORIDE

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Nanostructure Formation from Laser-Microwave Hybrid Processing of Zirconium Diboride Zirconium diboride, an ultra high temperature ceramic (~3000 °C melting point), can be hybrid processed in air or a controlled atmosphere to create unique nanostructures. Both nanorods and rectangular nanotubes have been formed while microwave arc heating the micron-sized ZrB2 powder in an alumina crucible. Laser + microwave hybrid heating is being researched as an alternative processing method. The morphology of these nanostructures is characterized using SEM and TEM. Energy dispersive x-ray spectroscopy (EDS) shows the composition as primarily zirconium and boron.

PB-10

ON LINE MEASUREMENTS OF GLASS AND SAPPHIRES PULSED LASER MICRO-DRILLING

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In order to produce a micro-hole for specific applications it is essential to select adequate parameters of the laser beam. We were focused in nanosecond pulse duration where the best results for laser drilling of optically transparent material were obtained using UV sources that could provide better results, than achievable by IR and visible sources. In the paper a study of different processing parameters is presented. Influence of parameters on drilling rate and on wall perforation were determined on-line. On the other hand entrance and output hole were analyzed after the processing by using optical and electron microscope.

PB-11

LASER REMOVAL OF OXIDE FROM TITANIUM ALLOY AND SURFACE CLEANING

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Thorough surface preparation is required for metals and their alloys, and in particular, for refractive and highly reactive metals and their alloys (Mo, Ta, Nb, W; Ti, Zr, Be) in order to achieve high quality bonds. Surface preparation process involves removal of oil, finger prints and grease, as well as, surface oxide. Current practices for surface preparation involve the use of organic solvents and acids like HCl, HNO3 and HF. Use of toxic chemicals creates cost and safety concerns for handling and disposal. We have examined the feasibility of laser removal of oxide from titanium alloy and surface cleaning process.

PB-12

DEVELOPMENT OF THIN-FILM LASER PATTERNING SYSTEM FOR FLAT PANEL DISPLAYS

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Laser patterning is a highly efficient technique for generating high resolution patterns on glass and plastic substrates. Laser patterning reduces the conventional photolithography-wet chemical etching process with its multiple steps of photoresist layer coating, UV lithography, exposure, soft baking, wet etching, and photoresist removal, to a simple single-step dry laser ablation process. As a result, the laser patterning technique reduces equipment costs, improves the process efficiency, and avoids the need for environmentally unfriendly chemical solutions. Although not in itself a new concept, manufacturers are only recently beginning to apply laser patterning to the field of flat panel displays (FDPs), including TFT-LCD, PDP, OLED and FlexD. Laser patterning involves a number of key systems and technologies, including the laser source and beam delivery system, precise synchronous motion schemes, and the laser ablation process itself. Obtaining an effective integration of these various components and obtaining deeper insights into the physical properties and characteristics of the laser patterning process is essential if the laser patterning technique is to be further advanced. ITRIS/ITRI has developed an excimer-laser-based patterning process system using a mask projection method (see Fig. 1). The patterning accuracy on a generation 2 glass is line/spaces >2.5µm. This study presents the design techniques of the beam delivery system and the synchronous schemes of laser and motion stage. In addition, the preliminary results obtained from patterning Indium Tin Oxide (ITO) on glass substrate are presented. The patterning result of the material ITO (see Fig. 2) shows that the line/spaces are approximately 3µm.

PB-13

REFRACTIVE INDICES ANOMALY OF SPUTTERED AMORPHOUS SIC AND SIN THIN FILMS.

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Refractive indices anomaly of sputtered amorphous SiC and SiN thin films.

PB-14

DYNAMIC ASPECTS OF LASER INDUCED BREAKDOWN NEAR THE AIR – WATER INTERFACE

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Optodynamic processes following the absorption of a laser pulse in the immediate vicinity of the liquid-air interface were studied experimentally. An IR laser pulse was focused near the distilled water surface and the generated optodynamic waves detected by beam deflection probe. From the analysis and comparison of the waveforms the size and the position of the optodynamic source relative to the interface was extracted. Moreover, the evolution of

the source shape as the laser focus is moved in steps from the air into the water and its relative strength can be deduced.

PB-15

F2 LASER MODIFICATION OF UV-TRANSPARENT POLYMER FOR SELECTIVE CELL PATTERNING

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In this paper, we report the F2 laser modification of UV-transparent polymer for selective cell patterning. Recently, Asahi glass Co. Ltd. has developed an amorphous fluoric-polymer called CYTOP which has high transmission range from 200 - 2000 nm and a refractive index of 1.34. The polymer is irradiated with F2 laser for surface modification. After the modification, HeLA cells were cultivated on only the irradiated area. Thus, selective culturing of cells on CYTOP by F2 laser modification would be attractive for 3D bioanalysis of living cells.

PB-16

STUDY ON LASER CONSOLIDATION OF METAL POWDER WITH YB FIBER LASER-TEMPERATURE MEASUREMENT OF LASER IRRADIATION SPOT-

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The layered manufacturing technique is one of the most effective processes for the manufacture of prototypes, tools and functional end products. In this study, in-process monitoring of the processing temperature at laser irradiation spot by two-color pyrometer, which has been developed by the authors, is proposed. In order to investigate the consolidation characteristics of chromium molybdenum steel (SCM) based powders with a Yb fiber laser, the maximum temperature at the irradiation spot of a laser beam was measured under various experimental conditions. The influence of the laser power and scanning conditions of laser beam on the temperature were evaluated.

PB-17

SIGNIFICANT MODIFICATION OF THE KNOOP HARDNESS OF A PHOSPHATE GLASS USING ULTRAVIOLET LASER RADIATION

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We present the effect of 193nm, 10ns excimer laser radiation on the Knoop surface hardness of a commercial phosphate glass. The glass examined is the Schott, Er/Yb-codoped IOG1 glass. A micro-indentation microscope is used for measuring the Knoop hardness. The results presented investigate the changes of the Knoop hardness between the pristine and exposed glass, which in turn are correlated with micro-Raman and refractive index change measurements. The results obtained reveal a significant decrease (10%<) of the Knoop hardness of the exposed glass, indicating the existence of volume dilation effects, induced by the 193nm radiation.

PB-18

FEMTOSECOND LASER PEENING OF THE STAINLESS STEEL

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Femtosecond laser peening has been demonstrated in the stainless steel. Vicker's microhardness was used to probe the residual stress and strain hardening caused by the laser peening. The hardness of laser-peened stainless steel was increased with increasing the laser intensity.

PB-19

HOLE DRILLING ON CEMENTED TUNGSTEN CARBIDE BY A FEMTOSECOND LASER

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Drilling of round holes on cemented tungsten carbide have been carried out by both percussion and trepanning methods. A laser used delivered 100fs pulse with repetition rate of 1kHz at 785nm. In percussion drilling, the hole depth increased with number of irradiated pulses up to 100 pulses. Further increase in the pulse number, however, did not increase the depth and only the diameter at the bottom increased. In trepanning, peripheral part was processed deeper than a core part at high scanning speeds. The difference between them was decreased at slower speeds and cylindrical shapes were formed.

PB-20

DIFFRACTION GRATINGS WRITTEN ON BBO FOR SUM FREQUENCY GENERATION OF FEMTOSECOND PULSES

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Diffraction gratings were written with femtosecond pulses on the surface of a BBO crystal. This diffractive element was used for non-collinear sum frequency generation of the fundamental and the second harmonic of a Ti:Sapphire femtosecond light pulses. The third harmonic signal (centred at 265nm) was maximized varying the tilt angle of the crystal for certain non-collinear directions.

PB-21

PERIODICALLY FINE-STRUCTURED THIN FILM SURFACE PROCESSED BY INTERFERING FEMTOSECOND LASER

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We generated new periodic and fine-structures by thin film processing using interfering femtosecond laser beams. The generated structures are "nanocrown", "whisker on nanobump" etc.. The basic structures changed according to the film structure, substrate, and laser property.

PB-22

SIZE PARAMETER EFFECT IN MIE SCATTERING MEDIATED NANOHOLE FABRICATION WITH FEMTOSECOND LASER

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Both Mie scattering and lens effects of transparent dielectric particles contribute to nano-processing by femtosecond laser, and each contribution strongly depends on the size of particles. We investigate experimentally the contribution of size parameter effects to nano-processing and simulate it by FDTD method. We used second harmonics and fundamental wavelength of 800 nm femtosecond laser. Experimental results showed that ablation

foot-print becomes almost the same if the size parameter is the same. Fabricated nanoholes became shallower as the size parameter became smaller.

PB-23

INSCRIPTION OF CYLINDRICAL AND PLANAR WAVEGUIDES WITH ULTRAFAST BESSEL BEAMS

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We fabricated planar and cylindrical waveguides in transparent dielectrics by using ultrafast Bessel beams instead of commonly used Gaussian beams. Excellent quality waveguides with low losses were produced by focusing millijoule femtosecond pulses with axicons.

PB-24

HIGH ENERGY, HIGH AVERAGE POWER ULTRAFAST AMPLIFIER FOR MICROMACHINING APPLICATIONS

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Industrial applications of femtosecond lasers, notably in the field of precision micro-machining, are rapidly increasing. The quality and flexibility of the interaction process are well established. In addition, many industrial processes require a high productivity, for which it is necessary to continuously increase the average power of ultrafast lasers. We report on a high power, high energy Ytterbium diode-pumped femtosecond laser, delivering up to 2 mJ pulse energy, sub-picosecond pulse duration, and average power up to 20W.

PB-25

ULTRAFAST DYNAMICS IN HIGHLY LOCALIZED OPTICAL BREAKDOWN OF BULK TRANSPARENT SOLIDS

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Ultrafast Dynamics in Highly Localized Optical Breakdown of Bulk Transparent Solids Illumination with focused femtosecond pulses leads to optical breakdown and subsequent permanent modification of transparent solids with a submicron resolution. We use pump-probe techniques in the highly localized interaction region to investigate electron and lattice dynamics. By monitoring the transient optical absorption of a weak pulse (at different wavelengths), we have a direct evaluation of free-carrier trapping dynamics for dielectrics with different band gaps (Fused SiO2, Sapphire, LiF, …). We discuss the relationship between the different optical breakdown dynamics observed for different intensity regimes and the permanent modifications induced in the materials.

PB-26

DEFOCUSING MICRO-LENSES SELF-FORMED BY REPEATED OPTICAL BREAKDOWN IN DIELECTRICS

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Defocusing Micro-Lenses Self-Formed by Repeated Optical Breakdown in Dielectrics We report on self-organized defocusing micro-lenses formed in transparent solids by repeated illumination with femtosecond laser pulses. We show that refractive index of dielectrics can be gradually decreased by few percents by multiple optical breakdowns. In fused silica, this strong reduction is due to the formation of self-organized nanometer-wide cracks. This material rearrangement does not increase scattering or absorption. However, it defocuses the ionizing laser beam, reducing progressively the nonlinear absorption of the successive pulses. This large refractive index change can be induced anywhere inside a 3-dimentional space with minimal material transfer. This opens a new route to adding new functionality to optical materials.

PB-27

FEMTOSECOND AND NANOSECOND UV LASER ANNEALING OF IMPLANTED SILICON CARBIDE

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In this work we present the effect of the laser pulse duration on the pulsed-laser-based post-implant annealing in order to restore the 4H-SiC crystal structure and to electrically activate the implanted doping species. We compare the optical properties, the crystallinity and the electrical properties of the laser annealed samples by means of femtosecond and nanosecond pulses. The annealed samples were p-type Al doped SiC wafers. Three lasers were used: an excimer laser at 248 nm at 30 ns and 500 fs pulse duration and a Nd:YAG laser at 266 nm, and 4 ns pulse duration. The “multiple irradiation method” was proven to be more efficient for the crystal recovery of the Al-doped 4H-SiC surface. FTIR and XRD analysis has shown a clear improvement of the crystal quality after the laser annealing. Raman analysis were correlated with electrical measurements.

PB-28

LASER-INDUCED AIR BREAKDOWN-BASED NANOFABRICATION

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Nanofabrication of metals and semiconductors by a technique of laser-induced air breakdown processing is considered. Such kind of processing takes place when pulsed infrared laser radiation is focused in atmospheric air near the target surface. The target serves to generate initial electrons and the formed plasma develops in the cold gas toward the focusing lens and absorbs main IR radiation power at its shock wave forefront through the inverse Bremsstrahlung mechanism and gets heated to very high temperatures (104 K). We show that in contrast to conventional UV laser ablation such treatment leads to a weak ablation of material that is clearly illustrated by the absence of crater under the irradiation spot. However, being ablated at some casual points, the material is released to high temperature plasma of air breakdown, serving as a “reactor”, which drastically transforms its properties. Finally, the material returns to the irradiation spot area and deposits on it forming a nanostructured layer. As an example, we consider the processing of Zn. We show that nanostructured ZnO layers, formed on Zn as a result of the processing, provide an intense exciton emission in the UV range (380-385 nm), while defect-related PL bands

were weak and could be completely removed by the varying fabrication parameters. Furthermore, ZnO layers were found to exhibit random lasing effect, associated with the presence of narrow emission lines within the exciton band. This phenomenon is normally attributed to a simultaneous high scattering and gain in some highly disordered media. Applications of nanostructured semiconductor and ZnO layers in optoelectronics and biosensing are discussed.

PB-29

DEPOSITION OF THIN FILMS COMPOSED OF FE81B13.5 SI3.5CO2 MATERIAL BY PLD METHOD USING THE ARF EXCIMER LASER

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Depositions of thin films, composed of Fe81B13.5 Si3.5Co2 material were performed with excimer laser of ArF type (= 193 nm). The Fe81B13.5 Si3.5Co2 material, with large magnetoelastic coefficient is potentially applicable in sensor technology. Depositions were prepared on the Si flat substrates, in different temperatures: RT, 250 oC, 500 oC and 700 oC. Results of influence of the laser fluence and laser operational frequency on morphology and magnetic properties of deposited films will be presented. As the diagnostics were used X-ray diffractometer (XRD), atomic force microscope (AFM), Fourier transform infrared spectrometer (FTIR) and transmission electron microscope (TEM).