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PROGRAMME GUIDE

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process. Qualification investigations using electron beam equipment shows that the precisely aligned multi shaped beam arrays are able to deflect the electron beams in the calculated values.

P-NANO-115 - Roll-to-roll UV nanoimprinting using flexible polymer stamp

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The flexible UV stamps were manufactured by using roll-to-roll imprinting on the fluorinated mold material (F-template) on polycarbonate substrate from Asahi Glass or cellulose acetate film from Clarifoil. Mold material was patterned with conventional thermal roll-to-roll nanoimprinting process using a flexible Ni-master as a stamp. This allows us to prepare tens of UV molds very easily for further processing. Patterned templates were cut off from the web and wrapped on two printing rolls thereby making a 'printing belt'. This belt works as a mold for roll-to-roll UV imprint experiments.

P-NANO-116 - 3D metallo-dielectric structures combining electrochemical and electroplating techniques

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We present a template-based synthesis of 3D metallic micro-wires. The template for the fabrication is macroporous silicon electrochemically etched. The pore arrangement is defined by lithographically pre-patterning. The deposition of the metal is guided by electroplating technique in nickel sulphamate bath. Macropores are homogenously filled with Ni at deposition rate controlled by time, temperature and bias. After the elimination of the silicon template in alkaline solution, metallic wires become a replica of the macropores.

P-NANO-117 - Towards high efficient zone plates for x-ray microscopy

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Modern x-ray microscopes use Fresnel zone plates as focusing optical elements. To minimize radiation load on the specimen the diffraction efficiency of this zone plates has to be maximized. The efficiency of x-ray optics strongly depends on the height of the diffracting zone structures. Hence the obtainable diffraction efficiency is limited by the achievable aspect ratios of the nanostructures. To overcome the fabrication limitations we developed a stack process to superimpose zone plates on top of each other. We show recent results of our new approach including polished zone plates on subsequent thinned membranes and the first stacked zone plates.

P-NANO-118 - Rapid injection molding of high aspect ratio nanostructures

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We propose a new nanoimprint method by applying injection molding for replication of high aspect ratio nanostructures in s short time. A plate current heater at the back of the nanostructured stamper realizes rapid heating and rapid cooling. In this research, we replicated several types of nanostructures including line and space and nanocone array with pitch of about 200 nm and aspect ratio of 1 - 3.

P-NANO-119 - Flexible and Transparent Tactile Sensor based on a Photosensitive Polymer

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This paper presents a novel designed tactile sensing array which will be introduced as artificial skin for robotics applications. The proposed artificial skin be employing extendable electrodes are highly flexible and durable so that it can conform to more complex surfaces without damaging the skin structure and the metal interconnects on the sensing array. SU-8 is employed as the main structure material of the skin, and metal is used as the tactile sensing elements. Figure 4 was shows the resistance change versus displacement. A 12_12 sensing array and with its size being 30mm_30mm is fabricated.

P-NANO-120 - Fabrication of plastic microchips with gold microelectrodes using techniques of sacrificed substrate and thermally activated solvent bonding

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We present novel complete process of fabrication of PMMA microchip with embedded gold electrodes, using sacrificed substrate technique, combined with thermally activated solvent bonding. The sacrificed substrate technique lies in combination of electrodeposition of gold and embedding of the gold structures into a UV curable resin. Isopropyl alcohol (IPA) is used as thermally activated solvent for PMMA bonding. At room temperature, IPA is not a solvent for PMMA. At elevated temperatures the solubility increases and IPA can be used as a bonding temperature decreasing agent. Experiments were carried out and the optimal bonding temperature and force were found (Tb=50°C, f=200N/cm2).

P-NANO-121 - Deeply etched surface-defined InP gratings for low-cost DFB laser processing based on newly developed ICP-RIE process

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A new ICP-RIE process was developed based on Cl2, CH4, H2 and Ar for the deep etching of surface defined InP gratings. Proximity corrected e-beam lithography was used to define 1st and 2nd order grating masks on the sample surface. Aspect ratios of about 1:15 could be obtained in 2nd order gratings with smooth side-walls and surfaces. The developed process is compatible with nanoimprint lithography, which allows high-throughput fabrication of high-performance low-cost DFB lasers for future high-speed data-com applications.

P-NANO-123 - Ultrafine PMMA/PVDF Core-Shell Fibers for Nanophotonic Applications

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Ultrafine fibers of Poly(methyl methacrylate) (PMMA)/Poly(vinylidene fluoride) (PVDF) with unique core-shell structure were fabricated via electrospinning, and they were adopted as optical waveguide materials. In order to enhance mode excitation efficiency CdSe/ZnS quantum dots were incorporated into PMMA as core material, PVDF was used as the cladding. These core-shell structured PMMA/PVDF ultrafine fibers were formed via one-step electrospinning by using two concentric syringes. The uniform core-shell morphology of PMMA/PVDF ultrafine fibers was confirmed by FE-scanning electron microscopy (FE-SEM) and transmission electron microscopy (TEM). Dispersion of quantum dots in PMMA/PVDF ultrafine fiber was observed via confocal laser scanning microscope.

P-NANO-124 - Zone plate based soft x-ray microscopy with improved spatial resolution by using high orders of diffraction

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We present an x-ray optical approach to significantly improve the spatial resolution of a Fresnel zone plate lens based full-field soft x-ray microscope. Using the third order of diffraction of an in-house fabricated zone plate objective with 25 nm outermost zone width , 14 nm lines and spaces of a multilayer test structure were clearly resolved. The obtained spatial resolution of the x-ray microscope is state of the art.

Flexible and Transparent Tactile Sensor based on a Photosensitive Polymer

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Keywords: SU-8, Flexible, Transparent, Piezoresistive, Tactile sensor

Summary

This paper presents a novel designed tactile sensing array which will be introduced as artificial skin for robotics applications. The proposed artificial skin be employing extendable electrodes are highly flexible and durable so that it can conform to more complex surfaces without damaging the skin structure and the metal interconnects on the sensing array. SU-8 is employed as the main structure material of the skin, and metal is used as the tactile sensing elements. Figure 4 was shows the resistance change versus displacement. A 12×12 sensing array and with its size being 30mm×30mm is fabricated. Furthermore, the sensor's resolution, size and shape can be easily tailored to the applications' requirements.

Motivation

Recently, the research on humanoid robots has been progressing rapidly around the world. In order to ensure effective and safe interactions between robots and humans, many sensing capabilities, such as tactile, temperature, vision and auditory senses, are indispensable. Flexible artificial skins with tactile array sensing capability are essential for robots to detect physical contact with humans/environment. MEMS tactile sensors are typically used for robotic end effectors to sense a contact force or pressure when touching objects. MEMS based tactile sensors offer several advantages over conventional sensors, including miniaturization, high sensitivity, and multi-dimensional functionality. MEMS tactile sensors are generally classified based on sensing mechanisms. These include piezoreistive[1], capacitive, piezoelectric[2] and optical tactile sensors[3]. Among them, piezoresistive tactile sensors are widely used because of their low-cost fabrication, good sensitivity, and simplicity of the electronic interface. Furthermore, recent reported researches focus on polymer-based MEMS tactile sensors using piezoresistance for sensing [4].

Results

Figure 1 shows the schematic diagram of designed tactile sensor with four strain gages (S_1~S_4). The size of the sensor is 30mm×30mm with membrane of thickness 200μm and its size being 600μm ×600μm. Under a given amount of membrane displacement at the center, the stress and strain experienced at the surface are proportional to the thickness of the membrane. From these statements, it is clear that the strain sensing elements in a tactile sensor must be placed at the surface and periphery of the membrane. The fabricated tactile sensor is made out of the negative-tone SU-8. It is an epoxy-based photoresist that is cross-linked, when exposed to UV light. After cross-linkage, SU-8 becomes thermally and chemically stable, making it an excellent material for permanent applications, especially for micro-machined transducers. The wide range of possible aspect ratios and structural thicknesses from material makes it an excellent choice for prototyping tactile sensor designs while compatible for handling potentially live cells. The process-flow of the fabrication of the tactile sensor is illustrated in Figure 2. Figure 3 shows the fabricated tactile sensor module. The size of one sensor module is 30mm×30mm. The resistance change of the strain gages are shown in Figure 4, which clearly shows the repeated and linear response of the resistance to the changed displacement. This result clearly demonstrated feasibility of metal strain gage based tactile sensors located on flexible polymer base. We have designed an all polymer-based MEMS tactile sensor which is capable of measuring force signals without interference. Finally, we a low-cost tactile device array using the presented surface modification and polymer micromachining techniques has been demonstrated.

Reference

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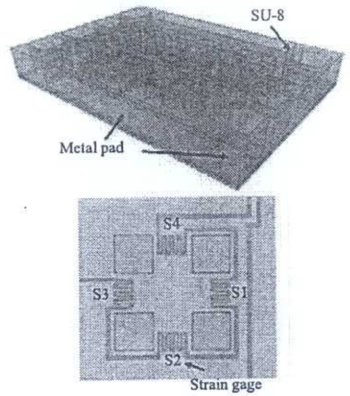

Figure 1. Design of a tactile sensor based on SU-8 and four strain gages S_1~S_4.

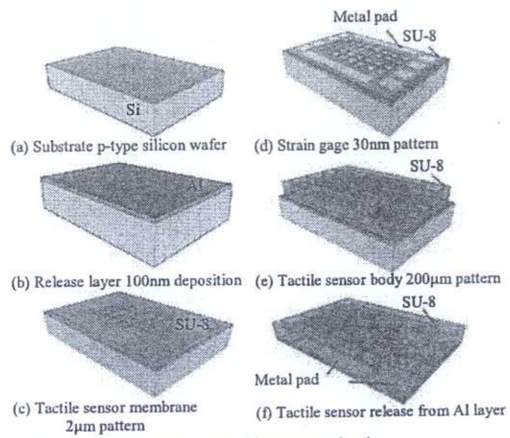

Figure 2. Process flow of key steps in the fabrication of a tactile sensor based on SU-8.

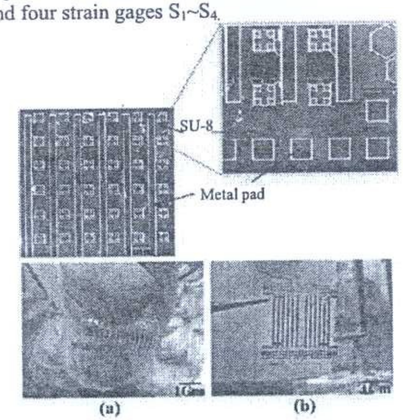

Figure 3. Optical images of the fabricated tactile sensor based on SU-8; (a) Sensor indicating its flexibility, (b) 12×12 tactile sensor (30mm×30mm and 200μm thick).

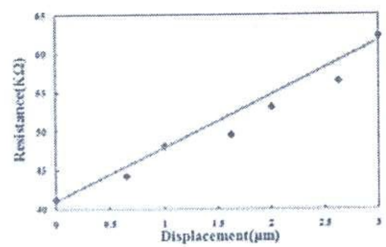

Figure 4. The output resistance change, versus the displacement of an individual taxel with linear fit line.