Publications with LPKF equipment

Selection of internationally published scientific articles using LPKF equipment

April 2022

Laser & Electronics

TOC: page, system, application

Laser & Electronics

LPKF ProtoLaser S4
LPKF Contac S4

Material used:
RO4350B, FR4, brass plate

Application area:
mm-wave antenna

Published:
02/2022

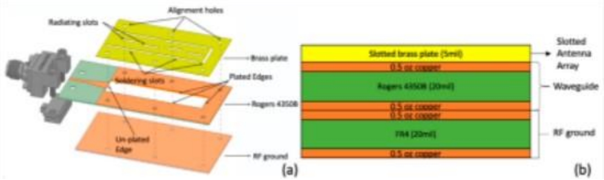
LPKF Laser & Electronics

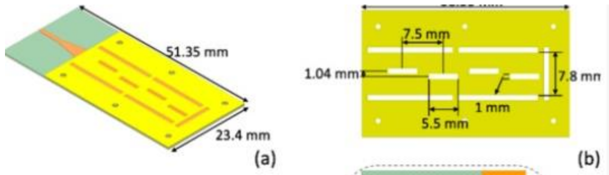
A Low-Cost and Efficient Microstrip-Fed Air-Substrate-Integrated Waveguide Slot Array

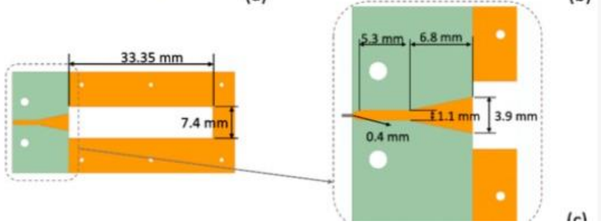
SIW, waveguide, slot array
mm-wave; 5G

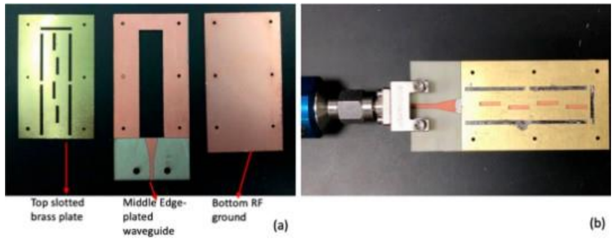
A microstrip-fed air-substrate-integrated waveguide (ASIW) slot array with high efficiency and low cost is presented. The design cuts out the substrate material within SIW, replaces the vias with metallic sidewalls, and uses a simple microstrip line-waveguide transition to feed the slot array. Radiating slots are cut on a 5-mil brass-plate, which covers the top of the substrate cutout to resemble a hollow waveguide structure. This implementation provides a simple and efficient antenna array solution for millimeter-wave (mm-wave) applications. Meanwhile, the fabrication is compatible with the standard printed circuit board (PCB) manufacturing process.

For prototyping, the radiating slots on the brass-plate, the waveguide, and microstrip lines were cut and milled using LPKF ProtoLaser S4 (LPKF Laser and Electronics, Garbsen, Germany). After cutting, the edges of the waveguide were copper-plated using an LPKF Contac S4 plating machine (LPKF Laser and Electronics, Garbsen, Germany). To plate only three edges of the waveguide, the RO4350B substrate was cut to form a five-sided hollow polygon as shown in Figure 5. After copper-plating, the protruding small triangle was cut out so that the input edge of the waveguide was not covered with copper. For the prototype, all the layers were aligned and soldered manually in the lab.









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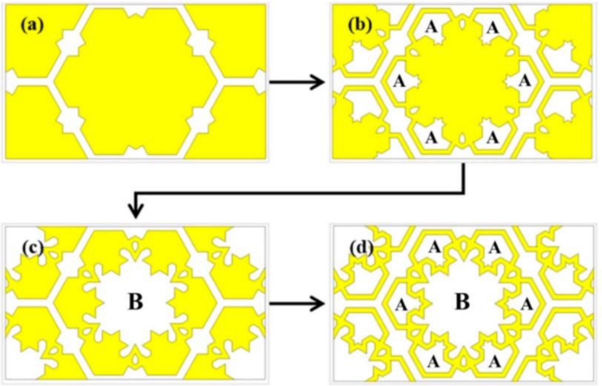
https://www.mdpi.com/2079-9292/10/3/338/htm

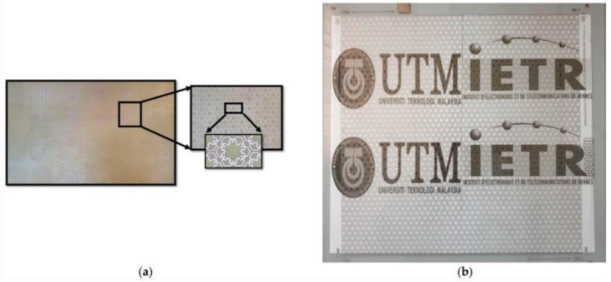
Optically Transparent Tri-Wideband Mosaic Frequency Selective Surface with Low Cross-Polarisation

mosaic frequency selective surface; fractal; optical transparency; wideband; low cross-polarisation

Acquiring an optically transparent feature on the wideband frequency selective surface (FSS), particularly for smart city applications (building window and transportation services) and vehicle windows, is a challenging task. Hence, this study assessed the performance of optically transparent mosaic frequency selective surfaces (MFSS) with a conductive metallic element unit cell that integrated Koch fractal and double hexagonal loop fabricated on a polycarbonate substrate. The opaque and transparent features of the MFSS were studied. While the study on opaque MFSS revealed the advantage of having wideband responses, the study on transparent MFSS was …



To evaluate the performance of the fabricated MFSS prototype, we characterised the prototype experimentally. The FSS 3 and the opaque MFSS was fabricated using the FR4 substrate through the LPKF Protolaser U4 laser machine, in which was performed at IETR (Université de Rennes 1, Rennes, France) (Figure 13a). The opaque MFSS unit cell with identical parameters was fabricated on the polycarbonate substrate for optical transparent application using the screen-printing technique that was performed at SERIBASE Industrie (Chateau-Gontier, France)



School of Electrical Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, Johor Bahru 81310, Malaysia

https://www.mdpi.com/1996-1944/15/2/622/htm

Material used: **FR4** | Application area: **Physics** | Published: **05/2021**

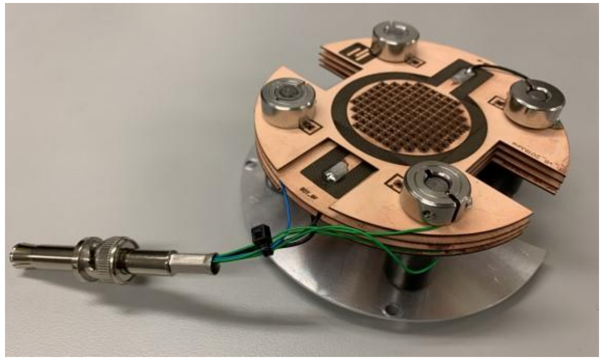
LPKF ProtoLaser U4

Laser & Electronics

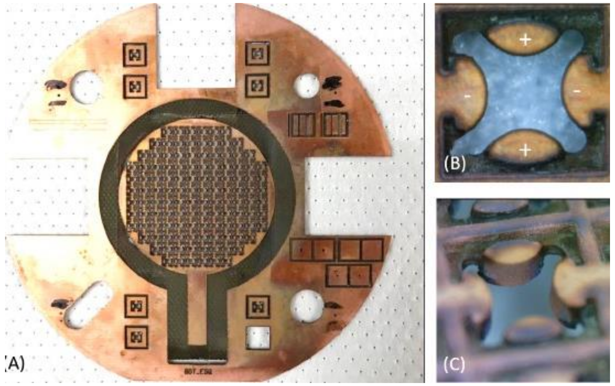
Beam power scale-up in MEMS based multi-beam ion accelerators

RF ion accelerator

We report on the development of multi-beam RF linear ion accelerators that are formed from stacks of low-cost wafers and describe the status of beam power scale-up using an array of 120 beams. The total argon ion current extracted from the 120-beamlet extraction column was 0:5 mA. The measured energy gain in each RF gap reached as high as 7:25 keV. We present a path of using this technology to achieve ion currents >1mA and ion energies >100 keV for applications in materials processing.



In order to accelerate all the ion beamlets extracted from the ion source, RF acceleration and ESQ beam focusing wafers with the same 120-beamlet pattern have been fabricated. For RF wafers, we used laser micromachining (LPKF ProtoLaser U4) to pattern the top and bottom metal layers, and to drill holes through the PCB. Alignment between the top and bottom is achieved by using an integrated vision system and prefabricated alignment fiducials. Steps of the process to fabricate RF wafers are given in Fig. 2. In this process, we start with a FR-4 based board that has copper cladded on both sides as seen in the cross section (Fig. 2(A)). The circular holes are created using a laser tool. Then laser cutting is used to define the top and bottom metal routing.



Acceleration Technology & Applied Physics, Lawrence Berkeley National Laboratory, 1 Cyclotron Road, CA 94720, USA

https://arxiv.org/pdf/2105.10611.pdf

LPKF ProtoLaser U3

Material used: **FR4**

Application area: **MEMS Sensor**

Published: **09/2021**

LPKF Laser & Electronics

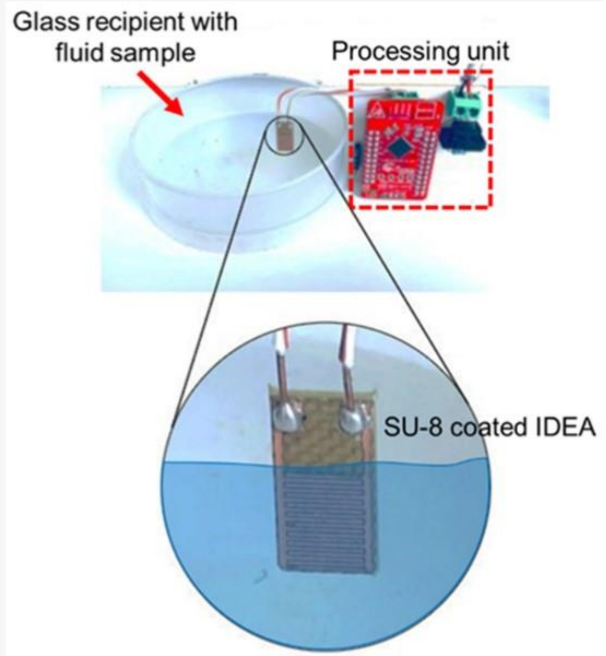
Sensitivity Analysis of a Portable Wireless PCB-MEMS Permittivity Sensor Node for Non-Invasive Liquid Recognition

MEMS, Permittivity Sensor, liquid recognition

ielectric characteristics are useful to determine crucial properties of liquids and to differentiate between liquid samples with similar physical characteristics. Liquid recognition has found applications in a broad variety of fields, including healthcare, food science, and quality inspection, among others. This work demonstrates the fabrication, instrumentation, and functionality of a portable wireless sensor node for the permittivity measurement of liquids that require characterization and differentiation. The node incorporates an interdigitated microelectrode array as a transducer and a microcontroller unit with radio communication electronics for data processing …

The ablation processing unit used in this work (LPKF ProtoLaser U3, LPKF Laser & Electronics, Garbsen, Germany) comprises a Nd:YAG laser operating at a wavelength of 355 nm, with a transversal intensity characterized by a Gaussian profile. The focused laser beam has a diameter of 12 µm. The laser was configured with an average power of 4.49 W and a pulse frequency of 53.75 kHz. The PCB consists of a 1.6 mm-thick FR4 substrate covered by an 18 µm-thick Cu layer on one of the planar surfaces. The IDEA pattern was designed in a Computer Aided Design (CAD) software and was then loaded on the ablation processing unit to transfer the pattern to the Cu layer of the PCB.

Figure 5. Experimental setup.



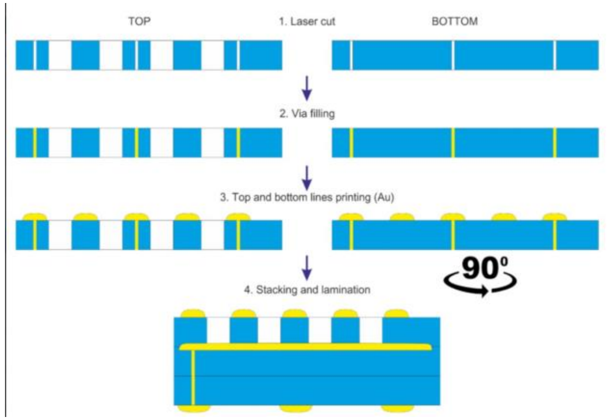
Tecnologico de Monterrey, School of Engineering and Sciences, Ave. Eugenio Garza Sada 2501, Monterrey 64849, Mexico

https://www.mdpi.com/2072-666X/12/9/1068/htm

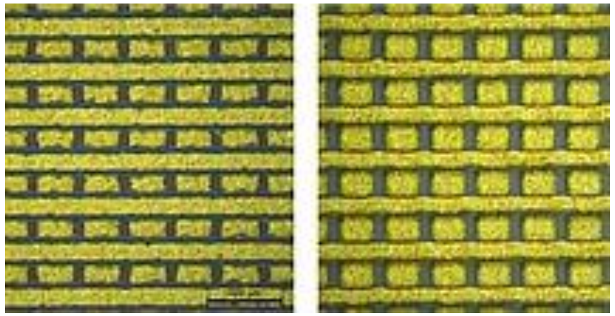
LTCC Strip Electrode Arrays for Gas Electron Multiplier Detectors

Gas Electron Multiplier (GEM) detector, X-ray, Micro Pattern Gas Detector (MPGD), solar radiation; space sensors

The Low Temperature Cofired Ceramic (LTCC) technology has proven to be highly suitable for 3D microstructures manufacturing in electronic devices due to its excellent electrical and mechanical properties. In this paper, a novel idea of implementing the LTCC structures into high-energy particle detectors technology is proposed. It can be applied in High Energy Physics (HEP) laboratories, where such sophisticated sensors are constantly exposed to particles of the TeV energy range for many years. The most advanced applications of the concept are based on dedicated gas amplifier systems coupled with readout microstructures.



The readout test structures were manufactured using DuPont 951 Low Temperature Cofired Ceramic (DuPont, Wilmington, DE, USA) green tapes, 254 µm thick. Their shape, basing, and via holes were cut in one step with a ProtoLaser U (LPKF, Garbsen, Germany) Nd:YAG laser, operating at a wavelength of 355 nm. Each structure had been designed to achieve the dimensions of 50 × 50 mm^2 after the firing process. The vias were filled with the TC0401 Ag/Pd transition paste (Heraeus, Hanau, Germany) by stencil printing and then dried at 100 °C for 10 min. Solder pads were screen printed on the bottom of the substrate, using first the 9145R silver paste (DuPont, USA) and subsequently the 963 silver-palladium paste (Electroscience Laboratory, Columbus, OH, USA)



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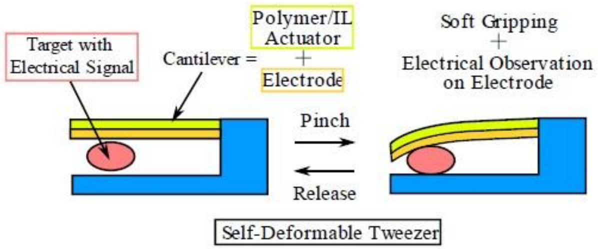
https://www.mdpi.com/1424-8220/22/2/623/htm

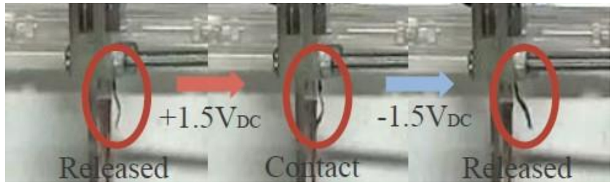
Self-deformable flexible mems tweezer made of poly (vinylidene fluoride) /ionic liquid gel with electrical measurement capability

Self-deformable cantilever, flexible actuator, soft gripping, PVDF-TrFE, ionic liquid, silver nanowire

We demonstrated a self-bending flexible tweezer capable of simultaneous mechanical handling and electrical measurement. A soft cantilever of 2mm × 8mm × 75µm bent by itself, and electrical signal observation through touched surface was successful. The working voltage (1.5V) was the lowest, and normalized strain was one of the highest values as compared to world's similar devices, to our best knowledge. Unique fabrication process of flexible cantilever with novel ionic polymer-metal composites (IPMCs) was developed. The material was poly (vinylidene fluoride-co-trifluoroethylene) (PVDF-TrFE) and ionic liquid (IL) by use of acetone solvent, and silver nanowire for electrodes.



The membranes were cut about 20×20mm squares before coating. They were put in a Petri dish and coated with silver nano wire of water solvent by a syringe. In order to evaporate solvent completely, the dish was heated on hot plate at 110 ºC for 8 minutes. The membrane was cooled down for 5 minutes at 25 ºC (room temperature.) This process was done to the other side of the membrane. The film was peeled off and cut into 2×10mm square by UV laser cutter (LPKF ProtoLaser U4). Thickness of obtained membranes with or without electrodes were observed by laser microscope LYMPUS LEXT OLS5000. Thickness of the membranes 30b, 50a, 50b, 70b after electrodes coated was 52.6, 65.6, 75.3, 87.7µm, respectively.

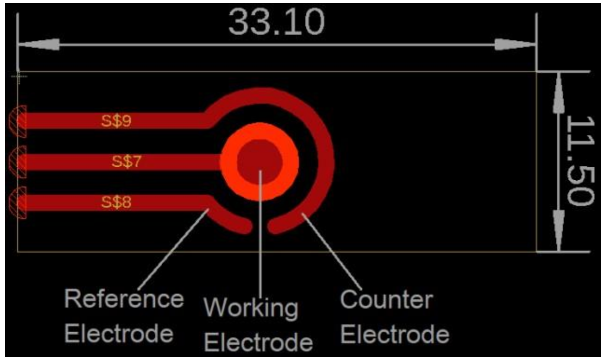


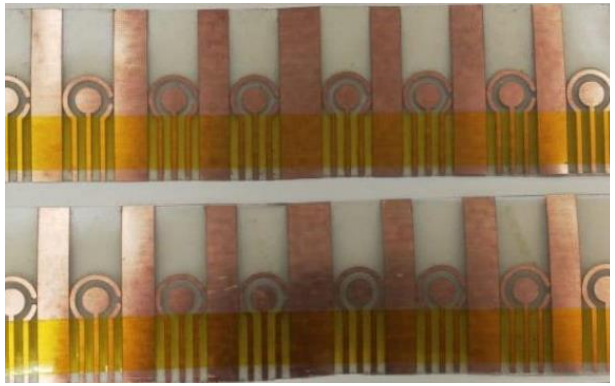
https://hal.archives-ouvertes.fr/hal-03426266/document

Carbamazepine Biosensor Development for Epilepsy Patient Screening

POCD, bio-medical devices

The San Carlos population in Chile is an example of an underserved community due to lack of timely access to regular controls and laboratory results. One particular challenge is the adherence to treatment of Epilepsy patients. In this work, we present the design and proof–of–concept of a Point of Care Device (POCD) to measure carbamazepine levels in saliva to screen for correct dose prescription among epilepsy patients. We present the Screen Printed Electrode design and activating circuit and preliminary results to verify feasibility of the biosensor. Future steps include the fabrication of the device itself and validation with the target population.





Screen Printed Electrodes: In the search for low-cost electrodes that can be produced on a large scale, ½ oz. flexible copper plates with a thickness of 0.8 mm are used. The shape of the electrode allows use of standard equipment to fit the three terminals: work electrode (WE), reference electrode (RE), and counter electrode (CE). The sample site of the WE has to be uniform and its size such that little solution is required to achieve an oxidation– reduction reaction (Redox) to indicate the concentration of the target enzyme. Also, about 10 mm at the end of the electrode have been left unused for easy handling. The electrode was designed in Autodesk Eagle electronic design software and implemented using an LPKF Protolaser S-Series LPKF printed circuit board printer.

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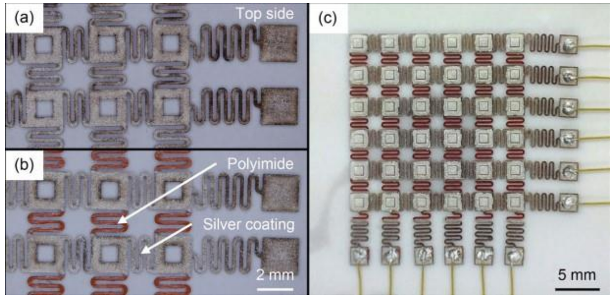
https://paperhost.org/proceedings/embs/EMBC21/files/1739.pdf

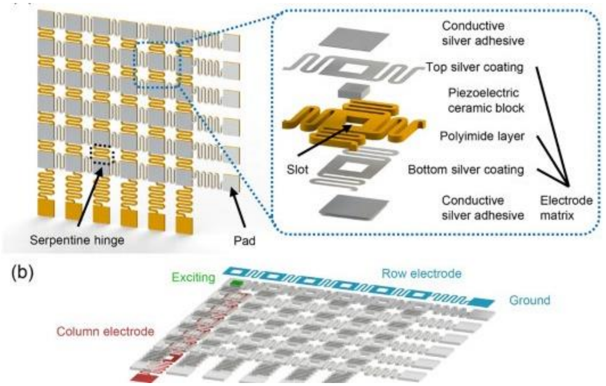
Design and micromachining of a stretchable two-dimensional ultrasonic array

Stretchable ultrasonic array, Serpentine hinge

Focused ultrasound using stretchable ultrasonic arrays is a very attractive method for ultrasound neuromodulation. However, the structure and fabrication of the arrays have brought great challenges for the development of stretchable ultrasonic arrays. In this work, an improved 6 × 6 stretchable two-dimensional ultrasonic array has been proposed based on laser micromachining technology. The structure and shape of the serpentine hinge are optimized to avoid delamination between layers and to reduce the stress concentration during the stretching process. Due to the thorough studies over the effects of laser parameters on the kerf profile, clean and accurate serpentine hinge shapes can be obtained conveniently.



The effects of laser micromachining parameters such as power, frequency, and repetition on the profile of the serpentine hinge were investigated using the LPKF ProtoLaser U3 System (LPKF Laser & Electronics, Garbsen, Germany), and the basic performance indexes of the laser system were shown in Table 1. The laser frequency indicates how many times the laser is switched on and off in one second. The laser repetition represents the number of repetitions of the laser micromachining process. In the experiments, serpentine hinges were processed using polyimide of the same size and thickness. An optical microscope (Zhongwei Kechuang Technology Co., Ltd., Shenzhen, China) was used for observing and evaluating the ablation depth of the kerf and the accuracy of the pattern profile under different laser micromachining parameters.



State Key Laboratory of Mechanics and Control of Mechanical Structures, Nanjing University of Aeronautics and Astronautics, Nanjing 210016, China

https://www.sciencedirect.com/science/article/pii/S2590007221000174

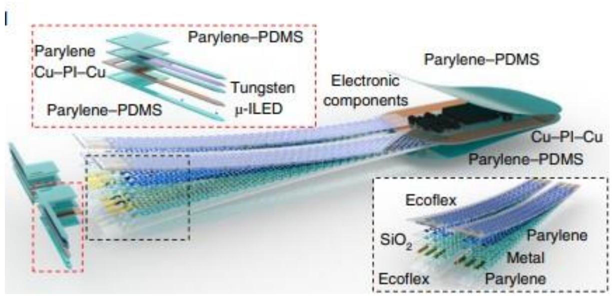
LPKF ProtoLaser U4

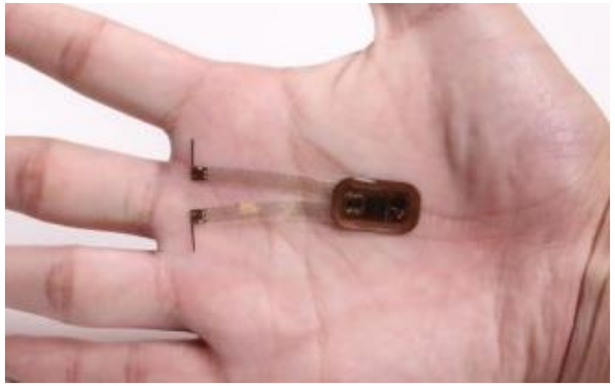
Wireless multilateral devices for optogenetic studies of individual and social behaviors

Optogenetic studies, social behaviors, implantable electronics

Advanced technologies for controlled delivery of light to targeted locations in biological tissues are essential to neuroscience research that applies optogenetics in animal models. Fully implantable, miniaturized devices with wireless control and power-harvesting strategies offer an appealing set of attributes in this context, particularly for studies that are incompatible with conventional fiber-optic approaches or battery-powered head stages. Limited programmable control and narrow options in illumination profiles constrain the use of existing devices. The results reported here overcome these drawbacks via two platforms, both with real-time user programmability over multiple independent…

Fabrication of the fexible circuit and probe. Patterned laser ablation (ProtoLaser U4, LPKF Laser & Electronics) of a fexible substrate of a copper–PI–copper laminate (18, 75 and 18µm; DuPont, Pyralux) defned the circuit interconnects, the bonding pads for the electronic components and the geometry of the probe. Flexible printed circuit boards with customized designs can be also obtained from commercial vendors (for example, PCBWay). Conductive pastes (Leitsilber 200 Silver Paint) flled laser-plated via holes through the substrate to electrically connect circuits on the top and bottom sides. Hot-air soldering using low-temperature solder (Indium) bonded packaged components and µ-ILEDs (TR2227, CREE, for emission at 460nm and 535nm; TCE12, III–V compounds, for emission…





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http://rogersgroup.northwestern.edu/files/2021/natureneurosocial.pdf

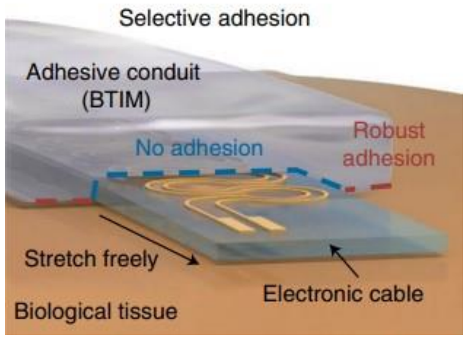
LPKF ProtoLaser R

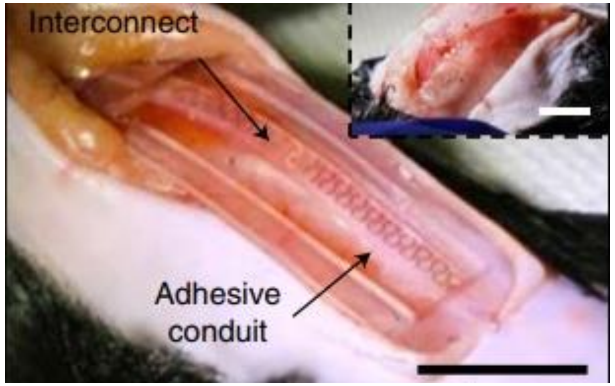
Photocurable bioresorbable adhesives as functional interfaces between flexible bioelectronic devices and soft biological tissues

Flexible bioelectronics devices, flexible sensors

Flexible electronic/optoelectronic systems that can intimately integrate onto the surfaces of vital organ systems have the potential to offer revolutionary diagnostic and therapeutic capabilities relevant to a wide spectrum of diseases and disorders. The critical interfaces between such technologies and living tissues must provide soft mechanical coupling and efficient optical/electrical/chemical exchange. Here, we introduce a functional adhesive bioelectronic–tissue interface material, in the forms of mechanically compliant, electrically conductive, and optically transparent encapsulating coatings, interfacial layers or supporting matrices.

3D electrode-exposed electronic systems. Fabrication began with patterning a layer of PLA (thickness ~50 µm) by laser cutting (ProtoLaser R; LPKF Laser & Electronics). Depositing Cr/Au (thickness 5/50nm) through a stencil mask (PI; thickness ~10 µm) by electron beam evaporation (AJA International) defined the pattern of electrodes. Deposition of SiO2 (thickness 100nm) through another stencil mask (PI; thickness ~10 µm) by sputtering (AJA International) on the backside of the PLA defined bonding sites. Exposing a prestretched silicone elastomer and the SiO2 surface on the PLA to UV ozone formed hydroxyl termination. Attaching PLA, as a 2D precursor, onto the stretched elastomer, followed by heating (60 °C, 15min) and releasing the prestrain, yielded the desired 3D …





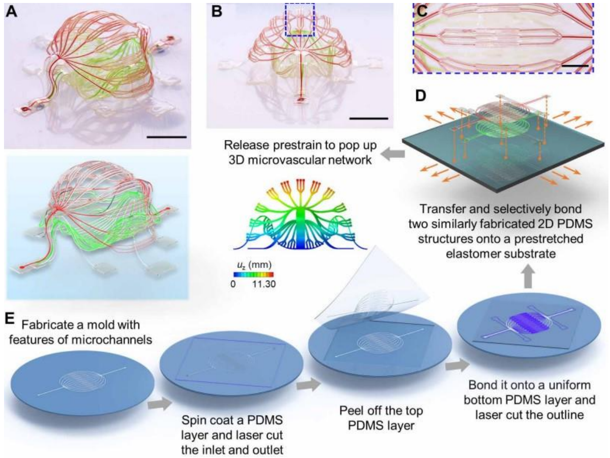
Center for Bio-Integrated Electronics, Northwestern University, Evanston, IL, USA

http://rogersgroup.northwestern.edu/files/2021/nmathydro.pdf

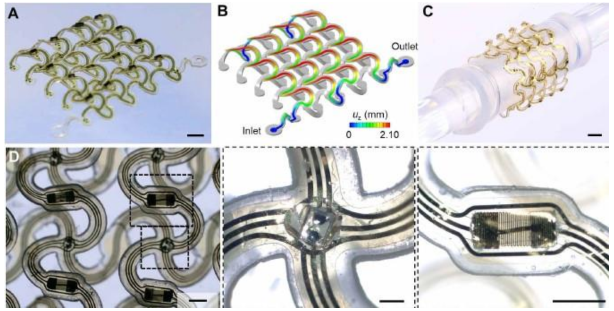
Complex 3D microfluidic architectures formed by mechanically guided compressive buckling

Microfluidics, lab-on-a-chip, organ-on-a-chip

Microfluidic technologies have wide-ranging applications in chemical analysis systems, drug delivery platforms, and artificial vascular networks. This latter area is particularly relevant to 3D cell cultures, engineered tissues, and artificial organs, where volumetric capabilities in fluid distribution are essential. Existing schemes for fabricating 3D microfluidic structures are constrained in realizing desired layout designs, producing physiologically relevant microvascular structures, and/or integrating active electronic/optoelectronic/microelectromechanical components for sensing and actuation. This paper presents a guided assembly approach that bypasses these limitations to …



Specifically, casting and curing PDMS against these lithographically prepared molds yielded solid elastomers with features of relief on their surfaces. A similar process performed on flat, bare silicon wafers formed films with uniform thicknesses. Bonding separate pieces of PDMS created in this manner (e.g., by oxygen plasma treatment, corona discharge, or UV induced ozone treatment, followed by heating on a hot plate at 110°C for ~5 min) defined sealed networks of microfluidic channels. Laser cutting (ProtoLaser R, LPKF Laser & Electronics AG, Germany) defined geometric outlines and generated openings to define the inlets for fluid transport. In certain cases, separately fabricated thin electronic systems or additional microfluidic layers with open architectures were …



Querrey Simpson Institute for Bioelectronics, Northwestern University, Evanston, IL 60208, USA

http://rogersgroup.northwestern.edu/files/2021/sciadv3dmicrofl.pdf

LPKF ProtoLaser U4

Material used:

PET

Application area:

Advanced material study

Published:

10/2020

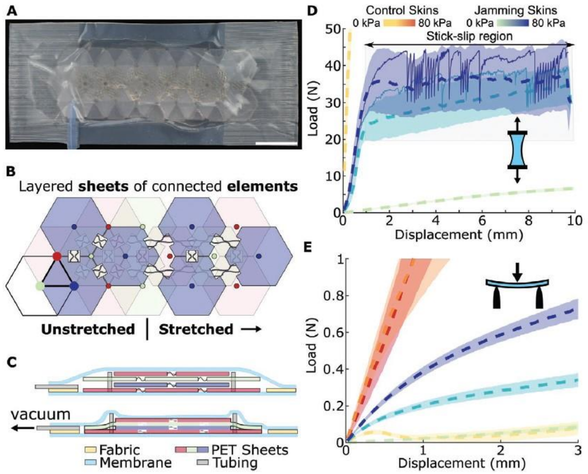
LPKF Laser & Electronics

Jamming Skins that Control System Rigidity from the Surface

laminar jamming, reconfigurable structures, shape locking, soft robotics

Numerous animals adapt their stiffness during natural motions to increase efficiency or environmental adaptability. For example, octopuses stiffen their tentacles to increase efficiency during reaching, and several species adjust their leg stiffness to maintain stability when running across varied terrain. Inspired by nature, variable-stiffness machines can switch between rigid and soft states. However, existing variable-stiffness systems are usually purpose-built for a particular application and lack universal adaptability. Here, reconfigurable stiffness-changing skins that can stretch and fold to create 3D structures or attach to the surface of objects to influence their rigidity…

Manufacturing: The jamming skins used in this study comprises a silicone membrane (Dragon Skin 10, Smooth-On), and layers of 0.1 mm thick PET that were laser cut (LPKF ProtoLaser U4) to make the jamming elements. Fiber-reinforced silicone[44] was used to connect the membrane seal to the jamming area. For the tension and bending tests, the dimensions of the active jamming area was 130 mm by 45 mm, the width chosen such that two jamming elements could fit side-by-side. Two larger skins based off of this jamming skin design were used for the application-oriented experiments: the 12-layer square membrane (Figures 3A,C,D and Figure 4) had an active jamming area of 130 mm by 130 mm and the larger 20-layer rectangular skin (Figure 3B) had a …



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https://www.dylanshah.com/publications/journal/2020/Shah%20et%20al.%20-%20Jamming%20Skins%20that%20Control%20System%20Rigidity%20from%20the%20Surface.pdf

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