A simple device for microinjections, manipulations and measurements with microinterferometric monitoring of the membrane / interface processes at the thickness range of 5-1000 nm at different angles

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Abstract:

A conventional technique for experimental morphological and membrane electrophysiological studies at one cell and membrane surface level is Micromanipulations, perfusions and measurements performed using glass microelectrodes crammed with an electrolyte. The typical (effective) diameter of the top of the glass microelectrode is from 500 up to but 100 nm, which prevents one from observing it employing a standard optical microscope in accordance with the optical resolution criteria, since the diameter but 500 nm is indistinguishable within the interference zone. Microprocessor programming of the puller (microforge) that gives pulling and tearing allows to get in certain regimes the adjusted diameter and shape of the micropipette tip, although this result is not fully controlled due to the above limitations. In this connection it's necessary to style the control devices for the micropipette tips both at the preparation and operation stages (intracellular or extracellular insertion). This method also should provide visualization of the processes occurring upon interaction of the microelectrode tip with the cell in real time, counting on the electrode type and state, which allows to level the artifacts arising with the systematic error frequency from the uncontrolled operation of the micropipette tip after alternative ways of the microelectrode filling with the electrolyte. We are using an installation scheme that is used to solve the above problems by means of introducing an interferometric device for microscopic control of the microelectrode and micromanipulator or microperfusor, for the first time for a given type of optical instruments combined with the interferometric optical scheme [A simple device for microinjections, manipulations and measurements using an electromorphological chip under microinterferometric control of the interface and membrane processes at the thickness range of 5-1000 nm at different angles; DOI: 10.26641/1997-9665.2017.4.7-17; https://arxiv.org/abs/1807.10137].

Introduction:

Oleg V. Gradov is that the Senior Researcher at the Semenov Institute of Chemical Physics (Russian Academy of Sciences, Moscow), working within the Department of Chemical and Biological Processes Dynamics. The recent works are spectroelectrochemical electro-morphological techniques, lab-on-a-chip designfor multispectral multiparametric mapping, chemometricmicrospectroscopy and ERD-SBGN-mapping of biological samples. He is the editorial board member of 10 journals and author of 150 journal papers (and >100 conference papers and reports). His recent grants include: "Lab-on-a-chip development for personalized diagnostics" (FASIE 0019125) and "Development of the novel physical methods for complex biomedical diagnostics supported position-sensitive mapping with the angular resolution at the tissue and cellular levels using analytical labs-on-a-chip" (RFBR 16-32-00914). He is also an envoy of "ASAPBio"* (Accelerating Science and Publication in Biology, based in Cambridge, USA) in Russia and member of several comities (Technical Committee on Standards, IEEE, Engineering in Medicine & Biology Society; Technical Committee on Biomedical Imaging &Image Processing, IEEE, Engineering in Medicine and Biology Society; IEEE Biometrics Council**; etc.).

A microdialysis probe has a semi-permeable membrane. Our probes have a 220 µm outer diameter. The probe inlet connects to a syringe pump which continuously perfuses through the probe. As the perfusate travels through the probe, analytes cross the membrane and travel out the probe outlet into sample vials on a fraction collector or to a sample loop of an analytical system via a narrow tubing. This valuable tool enables sampling of rather low molecular weight compounds from within the extracellular space of tissues.In the particular case of the brain and spinal cord, neurotransmitters are released to the extracellular space. The microdialysis implanted animals behave close to normal conditions.

We present a implantable intraocular pressure monitor microsystem, sub-mm3, fully wireless, ; that comprises a a pressure sensing IC, a piezoresistive micro-electro-mechanical system pressure sensor, an antenna, and powering coil . The system provides a 24-h pressure monitoring, which isn't possible with currently used tonometric measurements. The IMM volume is restricted to 0.38 mm3 (4 × smaller than previous state-of-the-art) for the studies on laboratory rodents before human use. A resonator magnetic coupling delivers the wireless power to the chip with 4.89% efficiency.

Discussion and Conclusion:

An optical beam profiler is introduced that uses a two-dimensional (2-D) small-tilt micromirrordevice.The use of this 2-D multipixel device opens up the important possibility of realizing several beam profile measurement concepts, such as a moving pinhole, a moving knife edge, a scanning slit, 2-D photodiode array and a variable aperture. Its key features include low polarization sensitivity, digital control, and wavelength independence, fast speed,. The experimental proof of the optical beam profiler concept using a 2-D digital micromirror device to simulate the 2-D moving knife edge indicates a small measurement error of 0.19% compared with the expected number based on a Gaussian beam-propagation analysis. Other 2-D pixel arrays such as a liquid-crystal-based 90° polarization rotator sandwiched between crossed polarizers can also be exploited for the optical beam whose polarization direction is known.

Coil-coupled passive sensors are often interrogated without contact, exploiting the magnetic coupling between two coils forming a telemetric proximity link. The readout unitis formed by a primary coil connected to the interface circuit , while the sensor unit is formed by passive sensor connected to a secondary coil . This effect is particularly marked for capacitance sensor units. In real operating conditions a compensation circuit is proposed to counteract the consequences of the parasitic input capacitance, and in which advantageously obtain distance-independent readings.

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