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Microneedle bio-sensor: Direct, label-free, real time detection of pH in biological cells

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Acid–base homeostasis and pH regulation inside the body is precisely controlled by kidney, lungs and buffer systems, because even a minor change from the normal value could severely affect many organs. Blood and urine pH tests are common in day-to-day clinical trials without much effort. Still, there is great demand for *in-vivo* pH testing to understand more about body metabolism and to provide effective treatments during diagnosis. The detection of pH at the single-cell level is hoping for the great level of clinical importance for the early detection of many diseases like cancer, diabetes, etc. In this research work, we have fabricated a micro region pH sensor by series of processes like electrolytic polishing to create needle structure, deposition of electrode materials using RF magnetron sputtering for pH measurements and finally testing in various biological mediums. Working and reference electrodes were $Ag/AgIO_3$ and Sb/Sb_2O_3 deposited on microneedles under optimized deposition parameters. The structural, elemental and morphological properties were analyzed using XRD, XPS, EDS and FE-SEM. The fabricated tip of the microneedle probe is around 5 μM analyzed by FE-SEM which size is comparable with the biological cells. pH testing initially began with using fish egg and various biological cells. The obtained pH sensing results were adequate with theoretical values. Since the sensor works at micro region, the potential difference is easily disturbed by atmospheric anomalies. Hence, many steps have been taken to improve the stability of the sensor. Besides that, fabricated microneedle sensor ability is proved through *in-vivo* testing in mice cerebrospinal fluid (CSF) and bladder. The pH sensor reported here is totally reversible and results were reproducible after several routine tests.

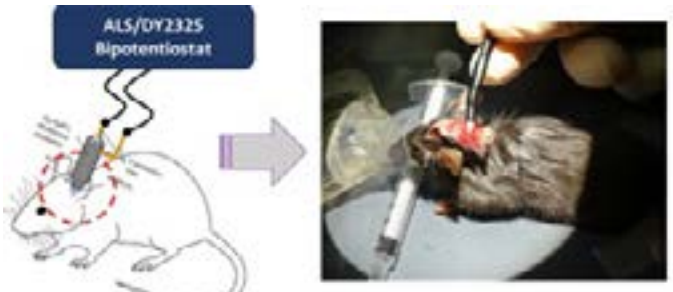

Fig. 1 Schematic of the microelectrode pH testing in mice cerebrospinal fluid

Biography

Ganesh Kumar Mani is a Researcher at Micro/Nano Technology Center, Tokai University, Japan. He has completed his PhD in Nano-Sensors Lab at Centre for Nanotechnology & Advanced Biomaterials (CeNTAB), Sastra University, Thanjavur, India. He published over 40 research papers in reputed international journals with the cumulative impact factor over 70 with a few papers under review. He is also one of the inventors in two patents titled "Low Concentration Ammonia Vapour Sensor" and "Acetaldehyde Sensor Using ZnO Nanoplatelets". He has also delivered several keynote lectures, organized national and international conferences in various countries. His current research interests are fabrication and development of nanostructured (Nanospheres, Nanorods, Nanowires, Nanoplatelets, Nanosheets) thin film based gas/chemical sensors for predicting food quality, developing microfluidics based solid state pH/temperature/bio-sensors for biomedical applications and developing painless microneedles for healthcare applications, etc.

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