All-Diamond Neural Probes for Neurochemical Detection and Neural Recording Applications

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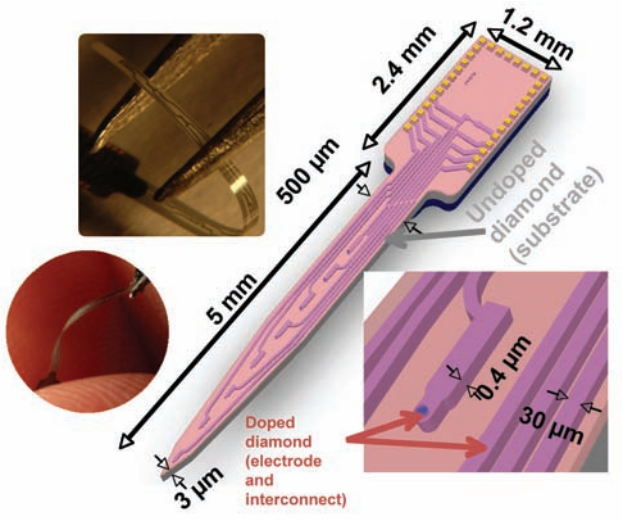
One of the key components in neural prosthetic systems is the microprobe, which is responsible for interfacing with neurons. This project aims to design and fabricate a novel all-diamond neural probe. Polycrystalline diamond is used as the material for the probe shank, interconnects/leads, and electrodes. Diamond is chosen because of its unique properties. It has one of the largest Young's moduli (~1011Pa) of all known materials. It has a large band gap (5.5eV), which is desirable for a substrate material. Diamond's optical transparency, furthermore, is useful for *in vitro* experiments as it allows electrodes on probes to be located easily under a microscope. In addition, boron-doped diamond's comparatively wide potential window in aqueous environments (-1V to 2V), low double layer capacitance (several $\mu F/cm^2$), chemical inertness and stability, resistance to fouling, and biocompatibility make it an excellent electrode material. For the first time, novel all-diamond neural probes have been successfully fabricated (see figure). Undoped diamond (resistivities of ~$10^5\Omega$cm) and highly boron-doped diamond (resistivities of ~$10^{-3}\Omega$cm) were used as the probe's shank material and electrode/interconnect material, respectively. The front portion of the probe is made solely from diamond. The probe has been successfully implanted in a guinea pig's brain, and *in vivo* neural activity has been recorded. In addition, with the integration of different electrodes (i.e., Pt counter and Ag/AgCl reference electrodes) on the probe's shank, it is capable of performing electrochemical detection. Currently, *in vitro* detection of neurotransmitters such as norepinephrine, dopamine, and serotonin has been performed with a detection limit on the order of a few nM ■



All-diamond neural probe.