In-vivo assessment of nanowire biocompatibility in the rat brain.

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Nanostructured surfaces can improve electrical properties of electrodes and lower evoked tissue responses in brain-machine interfaces[1, 2]. Nanowires have a great potential for the development of new types of brain electrodes. We have shown [3] that neurons can thrive on nanowire substrates, even when penetrated by the nanowires, which may indicate that the nanowires are biocompatible and which opens up for recording from individual neurons since the cell-electrode distance is very small. Here, we investigate the biocompatibility of nanowires in the brain. Gallium phosphide (GaP) nanowires (2 μm long and 100 nm in diameter) were epitaxially grown by Metal Organic Vapor Phase Epitaxy (MOVPE). The nanowires were coated with sputtered SiOx, which is known to be biocompatible. The samples were plasma treated before being immersed in a physiological solution and sonicated to break the nanowires off the surface. The nanowire suspension was then implanted into the rat brain. After 1, 6 and 12 weeks survival, the brains were sectioned and prepared for immunohistochemical investigations. Antibodies for microglia (ED1 positive cells), astroglial cells (GFAP positive cells), cell nuclei and neuronal nuclei were used. The ED1 positive cells constitute the signature of an inflammatory response in the brain, while the GFAP positive cells are involved in tissue repair. It was possible to visualize the nanowires (through the scattered laser light) inside the scar using confocal microscopy. Our results show that the inflammatory response decreased with time for the nanowire-implanted animals. The nanowires were distributed homogeneously along the scar one week after the implantation. After 6 weeks, the ED1 positive cells had ”collected” most of the nanowires. No signs of sub-acute of chronic toxicity associated with the injection of nanowires could be observed [4].

[1] E. W. Keefer et al., Carbon nanotube coating improves neuronal recordings. *Nature Nanotechnology* **3**, 434-439, 2008.
[2] G. Cellot et al. Carbon nanotubes might improve neuronal performance by favouring electrical shortcuts. *Nature Nanotechnology* **4**, 126-133, 2008
[3] W. Hällström et al., Gallium phosphide nanowires as a substrate for cultured neurons. Nano Letters 7 (10) : 2960-2965 Oct 2007.
[4] - C. E. Linsmeier et al., *Nanowire biocompatibility in the brain- looking for a needle in a 3D stack.* Nano Letters, 9 (12), 4184-4190, 2009.