

Stainless Steel Neural Probes Are Set to Enable Safer and More Accurate Brain Procedures

Engineers from Carnegie Mellon University in the U.S. have developed pioneering stainless steel neural probes that could make brain research and treatment much safer and more effective.

To read brain signals, scientists currently use neural probes manufactured from silicon. While silicon probes work effectively in thin, shallow tissue, silicon is a fragile material that can shatter during deep brain maneuvering, which can result in irreversible tissue damage. But engineering researchers at Carnegie Mellon University in Pittsburgh, Pa., USA, have fabricated the first stainless steel neural probe. This breakthrough enables customizable, high-density neural recording and makes brain readings much safer than before.

Using stainless steel probes, researchers are able to navigate to the middle brain with minimal cortical tissue damage, enabling inter- and intraoperative neural recording for epilepsy localization and deep-brain-stimulation implantation. They call these stainless steel neural probes “steelrodes.”

Stainless Steel Probes Outperform Silicon

“Silicon is widely used to make electronics and microelectromechanical devices. The reason is that microfabrication on silicon is well-established and mature. However, silicon is a brittle material. This makes silicon not the best choice to make implantable neural probes. These implantable neural probes usually have a long aspect ratio, i.e., they are thin and long and they can break easily if made of silicon,” explains Maysam Chamanzar, the lead on the research and Professor of Electrical and Computer

Engineering at Carnegie Mellon University. “Stainless steel, on the other hand, has a very high fracture toughness and cannot break easily. Moreover, it is a biocompatible material and can be safely placed inside the body.”

The microfabrication processes on stainless steel were previously not well developed compared to the fabrication processes on silicon, but the Carnegie Mellon team has developed a microfabrication process compatible with stainless steel substrates. “This leverages the existing standard steps of microfabrication and, therefore, the cost of the fabrication process at scale is comparable to the cost of manufacturing silicon neural probes,” says Chamanzar.

“As opposed to manually assembled neural probes that are manufactured one at a time, multiple of our ‘steelrodes’ can be fabricated in parallel. This is enabled by the scalable microfabrication process that we have developed. Our ‘steelrodes’ can be mass-produced using this manufacturing process at a fraction of the cost.” By fabricating high-density probes out of stainless steel, it is also possible to increase the length of the probes while strengthening their toughness, minimizing the risk of breakage.

Making Way for a New Class of Stainless Steel Devices

“Beyond creating robust stainless steel neural probes for clinical use, I’m excited that this work introduces

Editor

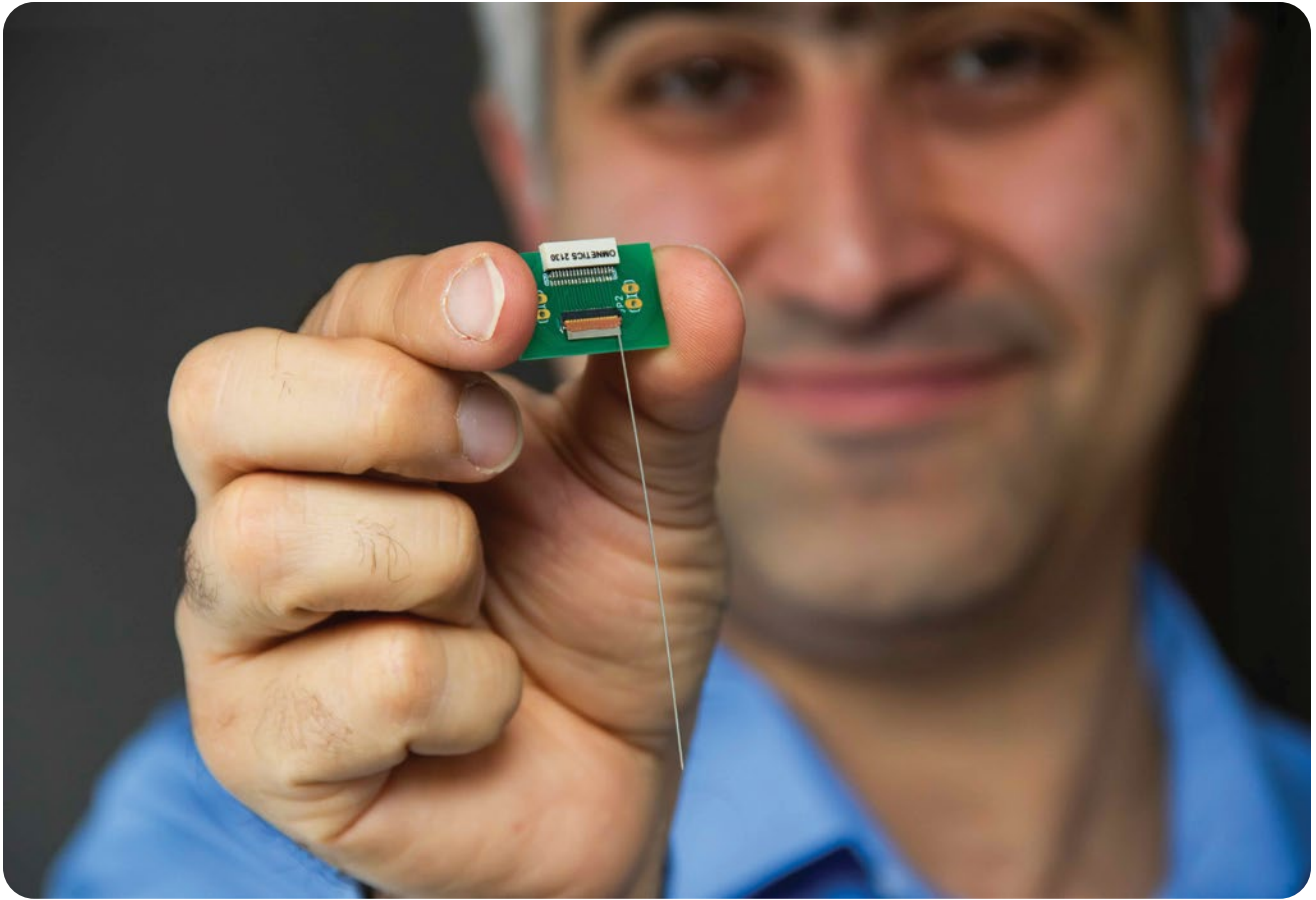
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Professor Maysam Chamanzar holds one of his stainless steel neural probes, which could transform brain procedures.

a novel planar microfabrication process directly on steel,” says Zahir Ahmed, who worked on this project as part of his Ph.D. thesis at Carnegie Mellon University. “This manufacturing process could lead to a new class of resilient devices that integrate multiple functionalities on steel that can be useful for a wide range of applications.”

As well as microfabrication on stainless steel, the team has also optimized post-fabrication processing and packaging. “Designed for seamless integration, our packaging method works effortlessly with commercial stimulation and recording systems, making it easy for researchers and medical professionals to readily adopt our stainless steel devices,” says Ibrahim Kimukin, a research scientist in Chamanzar’s lab.

In the future, the team hopes that neurosurgeons will be able to use multiple stainless-steel probes on a patient to generate a more comprehensive recording of brain activity. “Using ‘steelrodes,’ one day we will be able to record neural activity across multiple areas of the brain with high resolution and minimal damage to the brain tissue,” explains Chamanzar. “This crosshatch of neural recordings will change the diagnosis and treatment of brain diseases.”

The stainless steel neural probes can be used for neural recording and stimulation for diagnosis and therapeutic intervention of brain disorders, such as epilepsy and Parkinson’s Disease. Beyond neuro applications, Chamanzar says: “Our innovation approach opens doors for a variety of functional microfabricated stainless steel devices that can be safely implanted into the body for a gamut of other applications, such as orthopedics, cardiovascular interventions and hearing loss mitigation.” ♦