MASTERBOND®
CASE STUDY

MasterSil 912Med: Used to enable the re-implantation of probes for neural activity tracking

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Overview of MasterSil 912Med

MasterSil 912Med is a silicone system that has been specially formulated for bonding, sealing, and coating, primarily for medical devices. It passes both USP Class VI testing and ISO 10993-5 cytotoxicity standards and resists many sterilization techniques, including gamma and other types of radiation, EtO, as well as some liquid sterilants. MasterSil 912Med bonds well to a wide variety of substrates upon curing and is suitable for many medical device applications, including re-implantable neural probes to track the neural activity of free-moving mice.

Application

Recording neural activity in freely-moving animals can yield information about how their brains operate under realistic conditions. To provide this information, Neuropixels probes have been developed to offer insights into the neural activity of free-moving mice by recording data from hundreds of neurons simultaneously. However, Neuropixels probes are generally single-use and cannot be re-implanted after an experiment. As these probes are expensive and only available in limited quantities, this leads to high costs during experiments. Explanting and then re-implanting the Neuropixels probes require careful probe design, in part due to the fragile nature of the shank, which typically breaks during explantation.

Researchers at Cold Spring Harbor Laboratory developed a so-called Apparatus to Mount Individual Electrodes (AMIE) to encase and protect onboard electronics in the probe during long-term free-moving experiments in mice. Although the AMIE was designed to allow the probe to be explanted from one mouse and then re-implanted in a second mouse, the shank often broke during explantation attempts. To prevent this, the authors found it necessary to use MasterSil 912Med to further secure the shank and enable re-implantation of the probe.

Key Parameters and Requirements

The entire AMIE encasing weighed ~1.5 g and included the Neuropixels probe, an internal mount, and an external casing. The internal mount was attached to the Neuropixels PCB board with an adhesive, while the internal mount was attached to the external casing via a rail system. During implantation, all adhesive binding the assembly to the rodent's skull contacted only the external casing, which acted as a protective shell.

At least one day before implanting the probe, the authors attached it to an internal mount. As shown in ***Figure 1***, the authors used a needle to apply MasterSil 912Med to the base of the shank to further secure it. After drying, the probe was implanted and used to record neural activity in mice.

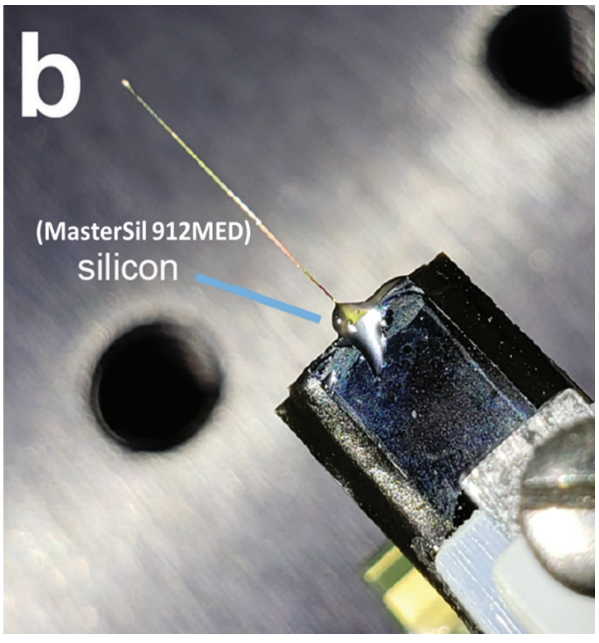

Figure 1. Photo showing the use of MasterSil 912Med to further secure the shank to the probe to prevent its breakage during explantation (modified from Ref. 1).

Results

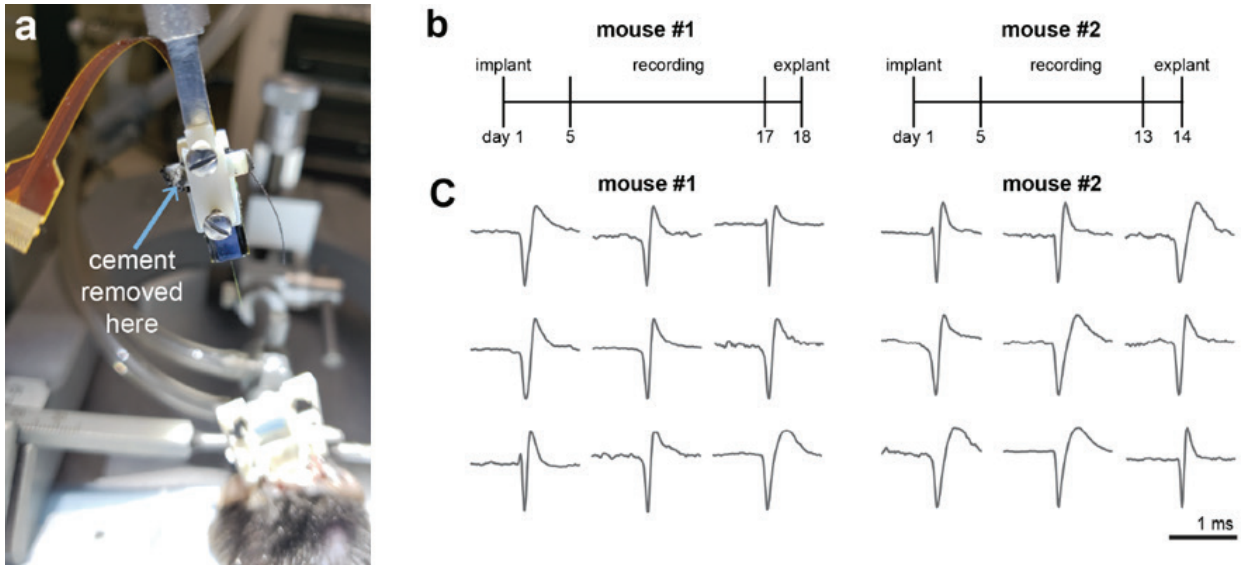

Figure 2. a) Explanted Neuropixels probe with an intact shank due to reinforcement with MasterSil 912Med, and b,c) probe performance after being re-implanted, showing no noticeable changes in performance (modified from ref. 1).

The probe casing developed by the researchers allowed them to characterize brain regions during freely-moving behavior for up to 41 days in mice without observable signal decay. After an experiment, the researchers removed the probe, which involved separating the internal mount from its external casing cemented to the mouse. The cement was drilled away, and the probe was removed from the mouse to recover an undamaged probe with an intact shank (***Figure 2a***). Then, the Neuropixels probe was re-implanted into a second mouse and showed no noticeable changes in the quality of its recording for up to 14 days (***Figure 2 b,c***).

The authors noted that applying a silicon adhesive like MasterSil 912Med appeared to be necessary to ensure that the explant was successful. Without MasterSil 912Med, only 1 of 6 explant attempts were successful because the shank broke either during the removal attempt or during free-moving recording. In contrast, all (4 out of 4) explant attempts were successful when using MasterSil 912Med, and two of these probes were successfully re-implanted, highlighting the critical role that the adhesive played in enabling the reuse of the Neuropixels probes.

References

Juavinett, A. L.; Bekheet, G.; Churchland, A. K. Chronically Implanted Neuropixels Probes Enable High-Yield Recordings in Freely Moving Mice. Elife 2019, 8, e47188. https://doi.org/10.7554/eLife.47188.