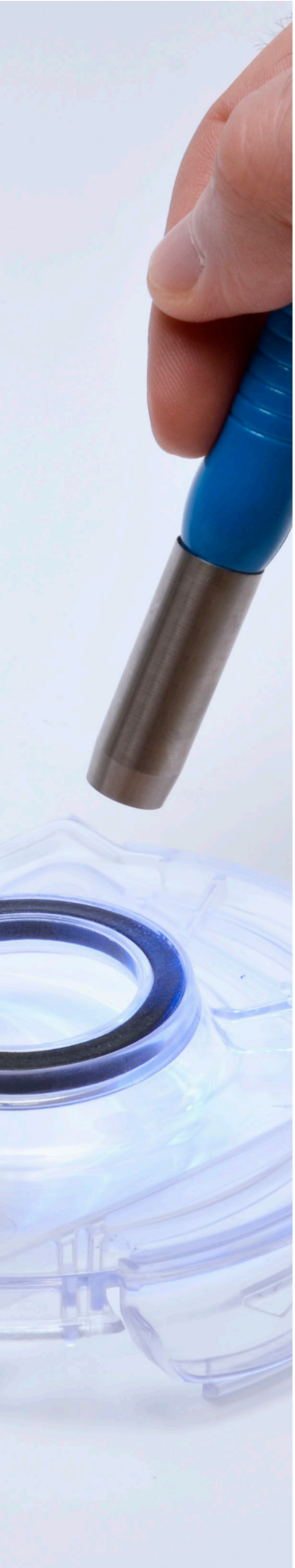

MASTERBOND®
CASE STUDY

UV15X-6Med-2: Used as a Biocompatible Encapsulant for a Wireless, Nerve Stimulation System

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Overview of UV15X-6Med-2

UV15X-6Med-2 is a one-component, medium-viscosity UV-curable system that offers high flexibility, toughness, abrasion resistance, and strong adhesion to substrates including glass, polycarbonates, acrylics, plastics, metals, and rubbers. It cures within 10-30 seconds under 320-365 nm UV light and provides excellent toughness, optical clarity, and electrical insulation. Its biocompatibility (passes USP Class VI and ISO 10993-5 cytotoxicity testing) and water resistance make it ideal for encapsulating implantable devices like wireless vagus nerve stimulation systems.

Application

Vagus nerve stimulation (VNS) has been investigated for treating conditions like epilepsy and drug-resistant depression, but conventional open-loop systems require trained personnel to manually adjust parameters. To overcome these limitations, researchers at UCLA developed a closed-loop, fully-automated wireless VNS (FAW-VNS) system with a biocompatible, miniaturized, wirelessly-powered implant. It featured a handheld power and communication device, a heart rate sensing patch, and a central control unit for dynamically adjusting stimulation in real time.

To ensure the long-term safety, reliability, and functionality of the FAW-VNS within the body, the authors encapsulated it with UV15X-6Med-2 to provide a biocompatible barrier that prevented tissue damage while protecting sensitive electronics from moisture and corrosion.

Key Parameters and Requirements

The implant was made of a flexible polyimide board housing the stimulator chip, wireless power transfer (WPT) coil, surface mount devices (SMDs), and cuff electrodes. The SMDs included a tuning capacitor for the coil, a storage capacitor for the chip, a diode as a visual stimulation indicator, a charge-balancing capacitor, and a discharge resistor. The cuff electrodes and SMD components were assembled on the PCB using a silver epoxy. The assembled implant was packaged with Master Bond UV15X-6Med-2 to provide a biocompatible, electrically insulating barrier against water intrusion or corrosion from the surrounding environment when implanted.

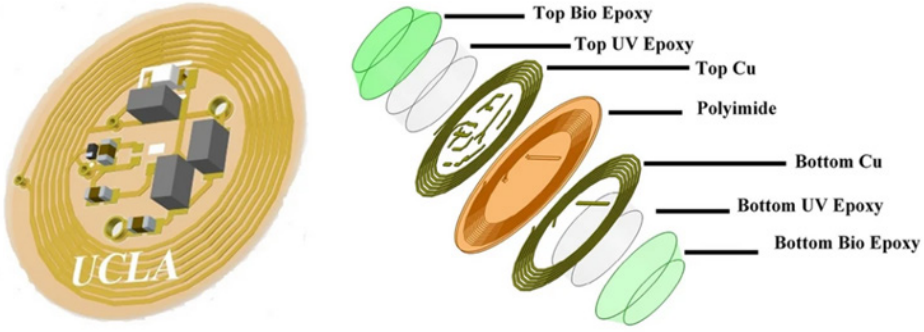

Figure 1. Diagram showing the 3D stack-up of the different layers of the implantable vagus nerve stimulator, which was encapsulated with UV15X-6Med-2 (Top Bio Epoxy).

UV15X-6Med-2 generally cures in 10-30 seconds at ambient temperatures when exposed to 320-365 nm UV light, and can cure in sections approaching 1/4 inch thick without oxygen inhibition.

Results

The protective function of UV15X-6Med-2 was evaluated by prolonged immersion in phosphate-buffered saline (PBS) to simulate physiological conditions. The salt content of PBS is challenging for electronics because it accelerates corrosion and mimics the ionic conductivity of bodily fluids. Despite continuous exposure to PBS for 20 days, the device maintained consistent stimulation (***Figure 2***) throughout the test. This stability indicates that encapsulation by UV15X-6Med-2 prevented the saline solution from reaching the electronics and corroding its metallic components.

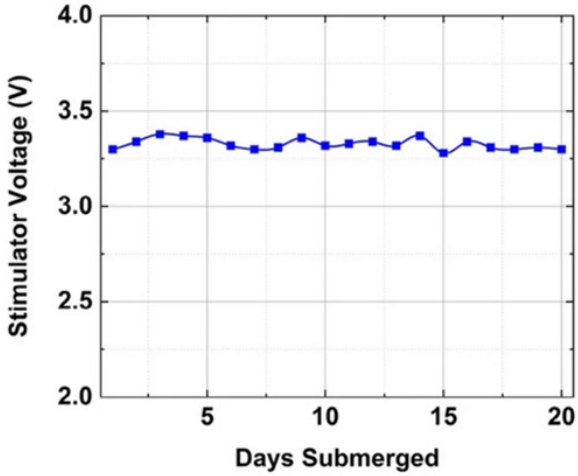

Figure 2. Vagus nerve stimulator encapsulated with UV15X-6Med-2 showing consistent performance during 20 days of submersion in PBS.

In-vivo tests

After demonstrating that UV15X-6Med-2 protected the FAW-VNS system during immersion in PBS, the system was implanted in four anesthetized pigs for in vivo testing (***Figure 3***). The results showed that the system reduced initial HR drops (10% open incision, 6% closed) to less than 2.5% by adaptively tuning the duty cycle and frequency without needing human intervention. It also maintained stimulation above the nerve activation threshold and demonstrated automated control across multiple subjects.

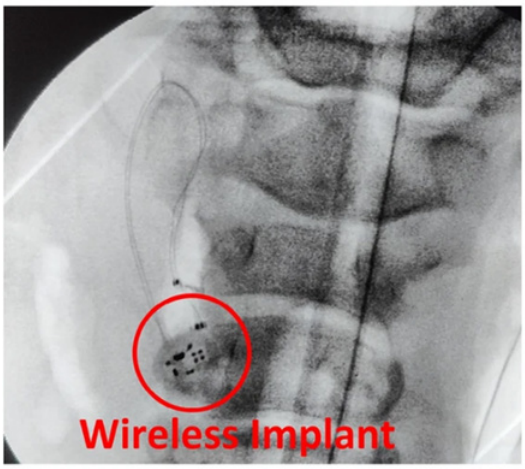

Figure 3. X-ray image of the wireless implanted vagus nerve stimulator encapsulated by UV15X-6Med-2.

Conclusions

This paper presented FAW-VNS as the first batteryless, fully automated wireless vagus nerve stimulation system capable of real-time closed-loop control. After assembly, the entire system was encapsulated in UV15X-6Med-2, which acted as a barrier that allowed the device to perform consistently for 20 days in PBS. In vivo tests showed that the system adjusted stimulation parameters based on heart rate data to achieve the neural fulcrum while minimizing bradycardia in four anesthetized pigs. UV15X-6Med-2 provided a biocompatible barrier for this closed-loop, wireless implantable device that prevented intrusion from bodily fluids after being implanted, helping ensure the long-term stable operation of the device.

Reference

Mathews, R.P., Habibagahi, I., Jafari Sharemi, H. et al. A closed loop fully automated wireless vagus nerve stimulation system. Sci Rep 15, 27856 (2025). https://doi.org/10.1038/s41598-025-11159-8