ACTION–Hermetic Packages and Flexible Substrates for Implants

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In the frame of the European Project ACTION, CSEM and its consortium partners developed a prototype implantable laser to explore the optoacoustic effect. This effect is used to stimulate hearing nerves in the cochlea through the generation of a sound wave in the cochlea fluid. The sound wave is created by laser light absorbed in the fluid.

One of the core activities of CSEM in this project was the development of a package (i.e. housing) for the laser. It has to be kept in mind that the human body reacts aggressively to foreign bodies and that certain materials used in the semiconductor industries may be toxic or even carcinogenic. Therefore, the package has to be hermetically sealed in order to prevent leaching of toxic substances and ingress of moisture, which might damage the internal electronics. Material choice for the package is for the same reasons limited to a small selection of metals, ceramics and polymers. Latter are, however, not suitable to protect the laser and internal electronics over a period of several years. A proprietary laser assisted bonding process allowed us to hermetically seal a miniature sapphire package with cavity dimensions as small as $0.6 \times 0.6 \times 1.2\ mm^3$ (Figure 1). Sapphire has all the properties required for this application. It is a strong material, chemically stable and non-toxic to the body. In fact alumina, which is the amorphous version of sapphire, has a long track record in long-term medical implants. Furthermore, sapphire is highly transparent in the wavelength range of the emitted laser light.

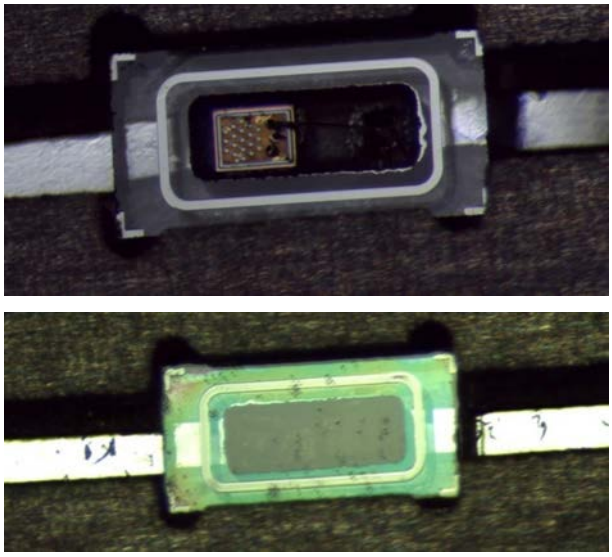

Figure 1: Sapphire micropackage. Before sealing (top). The VCSEL is visible in the pocket. After sealing (bottom). The uniform green colour indicates a successful bond of constant bondline thickness.

A further feature of the miniature package are two hermetic feedthroughs, exclusively made of biocompatible materials. The feedthroughs are integrated in the bottom of the package. The electric connections extend horizontally beyond the side walls. These easily accessible platinum ribbons may then be laser, spot or resistance welded to a platinum wire.

We also developed a flexible substrate (i.e. flex print, Figure 2) for the VCSEL. It provides mechanical support and electric connection. It is made of the biocompatible materials silicone and platinum.

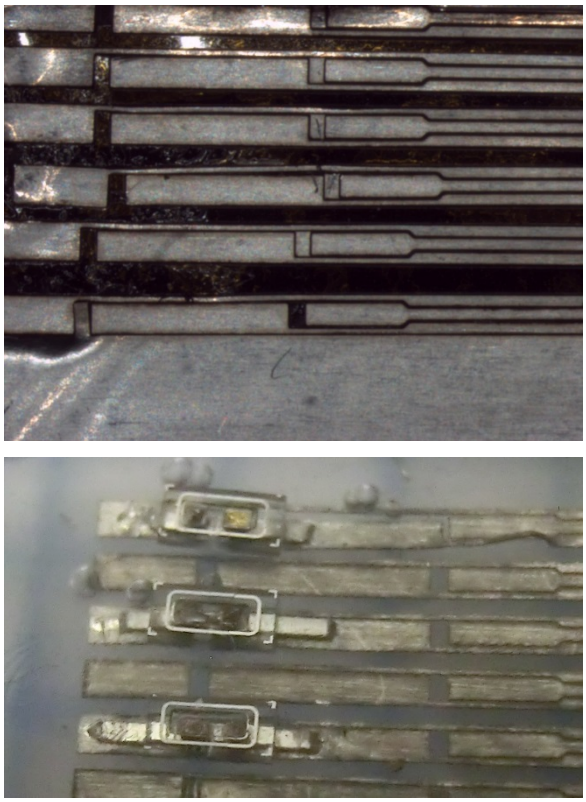

Figure 2: (top) Laser milled platinum foil. The structure of the flex print is repeated several times; (bottom) three packages welded to the flex prints. Separation of the devices is the last step in the manufacturing process.

The development of a package and further key technologies at CSEM and its project partners opens the door for implantable light sources. The ongoing miniaturization of the components – essential for cochlear implants – has two further advantages: On one hand, it will allow new medical treatments due to the fact that smaller implants may be placed in parts of the body which are inaccessible to current size implants. On the other hand, surgical procedures will be less invasive. The patient benefits too because, for example, only local anesthetics will be required. Recovery will be much quicker and the procedure cheaper.

The competences that CSEM builds within the frame of this EU-project are not restricted to medical applications. Packaging solutions for microsystems in harsh environments are door openers for many industrial applications. CSEM is willing and prepared to support industrial partners in Switzerland.

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