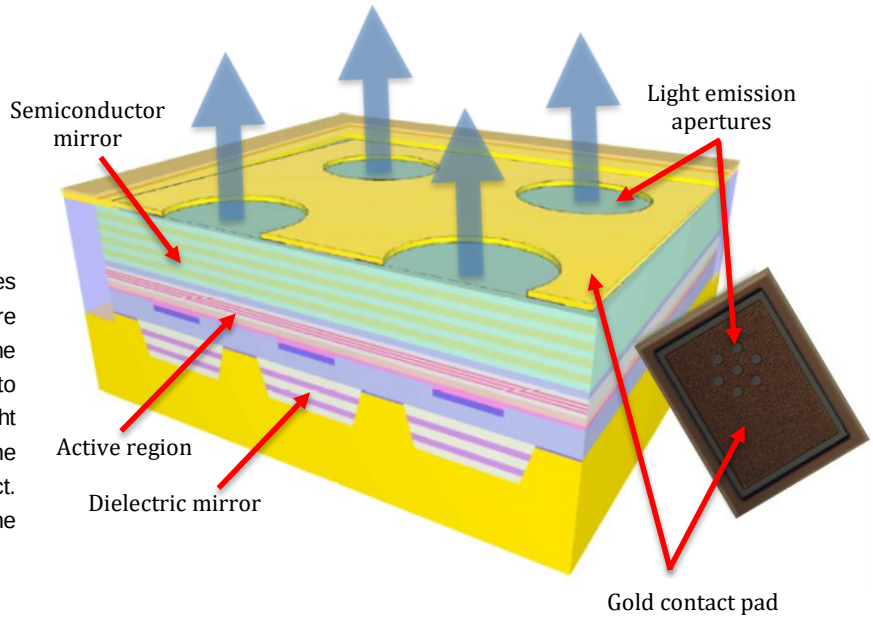
ACTive Implant for Optoacoustic Natural sound enhancement

SEVENTH FRAMEWORK PROGRAMME

Long Wavelength VCSEL arrays

Vertical Cavity Surface Emitting Lasers (VCSELs) are the sources of near-infrared light used in ACTION. Up to 19 VCSELs are combined into an array which is small enough to implant into the cochlea while still providing the necessary optical power to stimulate hearing in residual hair cells. 1550 nm and 1860 nm light pulses from VCSEL arrays placed at different locations in the cochlea generate different sounds via the optoacoustic effect. Specifically designed silicon micro-lenses are used to focus the light to increase the stimulation efficiency.



VCSEL design

VCSELs are a family of semiconductor lasers which can convert electrical energy into laser light energy which is emitted perpendicularly (as opposed to parallel) to the substrate on which the laser is fabricated.

VERTILAS long wavelength VCSELs are based on the Indium Phosphide material system and use a multiple-quantum-well active region. The active region is bounded by two very high reflectivity (>99%) Bragg mirrors which are made from semiconductor and dielectric materials respectively. Light, generated by electricity passing through the active region, bounces between these two mirrors and is amplified to very high intensity. A small portion of this light exits through the top mirror and is focused via a micro-lens onto the cochlea of the patient.

Restrictions in the cochlea

Creating a light source that is suitable for implantation is challenging. The entire implant can only be 1 mm in diameter and must include the VCSEL array, the micro lens, the sealed packaging, the electrical connections, the anti-biofouling layer and the flexible substrate on which everything sits.

In addition, the cochlear must not get hot due to the implant. The electric current needed to drive the VCSEL will produce heat that must be dissipated. To minimize this heating, the VCSEL array does not operate continuously but rather is pulsed so that no current is flowing when not required. The VCSEL arrays are designed with a hexagonal geometry with an optimal 50 um pitch between the apertures to minimize thermal cross talk effects. Internal design parameters are focused on achieving maximum output powers with the highest possible wall-plug efficiencies.

Project partners

MED-EL, CSEM SA, Medizinische Hochschule Hannover, Teknologian tutkimuskeskus VTT Oy, SUSS MicroOptics SA, VERTILAS GmbH, STMicroelectronics SRL

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