Laser welding of cerumen protectors on Phonak hearing aids

Better hearing thanks to laser welding

The development of hearing aids has been facilitated by the incorporation of laser welding using the mask welding concept. It is necessary to provide protection in the area of the sound outlet in order to guarantee reliable functioning of hearing aids that are getting ever smaller and which are worn within the ear. In the novel «SmartGuard» cerumen protection concept by Phonak, a highly elastic, extremely thin diaphragm is welded onto a small carrier ring. The mask welding process, developed and patented by Leister Process Technologies, enables this high-precision joining process.

Protection from contamination

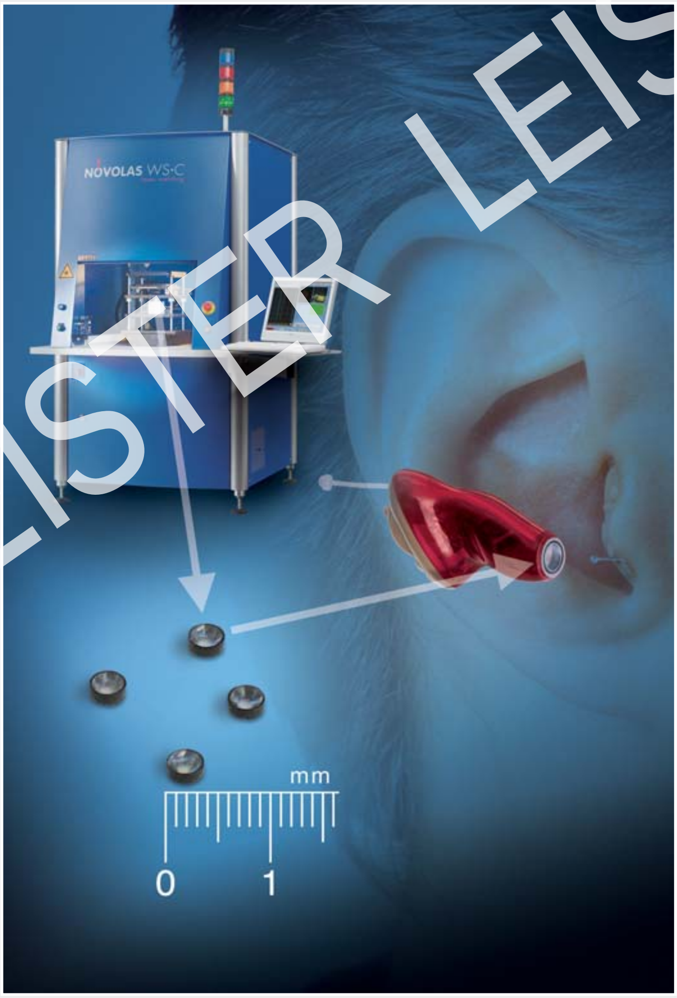
Hardness of hearing and reduced hearing capability is widespread. In many cases these conditions can be relieved to a large degree by the use of modern hearing aids.

A typical ITE hearing aid is nowadays only as big as the tip of your little finger.

Continuous development of hearing aids also leads to miniaturisation, with the aim of providing the user with smaller, more comfortable and virtually invisible hearing aids. There are different types of hearing aids which differ in their shape: so-called BTE (behind the ear) hearing aids and the considerably smaller ITE (in the ear) hearing aids. In addition to the technical differences, the ITE hearing aids primarily have the optical advantage that, depending upon the shape, they are virtually invisible from the outside.

A big problem with all hearing aids is the contamination of the sound outlet by ear wax in the auditory channel, the so-called cerumen. The loudspeaker – also called the earpiece – is located deep within the ear channel, particularly in the case of the ITE hearing aids. In order to ensure long-term functioning this must be effectively protected from contamination and moisture. The demands on such protection are high: In addition to the acoustic properties, strength, durability and media resistance as well as consistent high quality play a significant role.

The Swiss hearing aid specialist Phonak has a turnover of more than a billion Swiss Francs and a global market share of 16 to 17 % and is thus one of the leading hearing aid manufacturers in the world. Phonak is constantly making new innovations that make a considerable contribution to



The diaphragm is welded upon the cerumen protection on a Leister WS (work station).

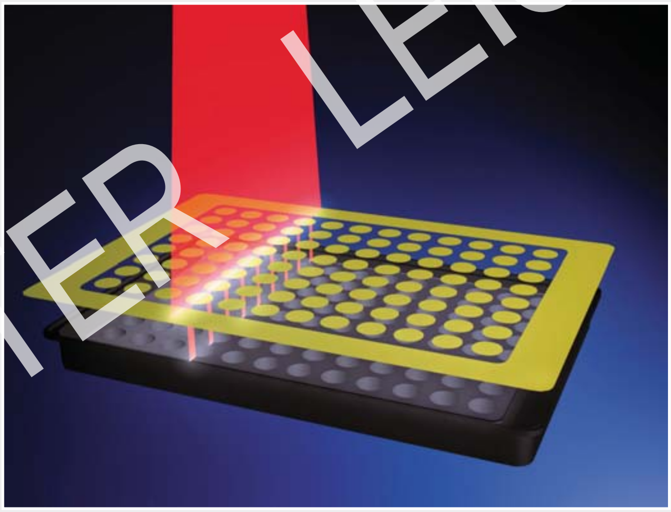
the improvement in quality of life of people with hearing damage. One of these innovations is the new cerumen protector «SmartGuard». This uses a 15 µm thick polymer diaphragm to protect the sound outlet from cerumen and moisture, without having any significant deleterious effect on the acoustic properties. The diaphragm is mounted on a thermoplastic carrier ring. The strength of the connection to the carrier ring is high, despite the small area of the joint. Any deposits on the diaphragm can be removed by regular wiping with a soft cloth. This does not damage the diaphragm or the connection to the carrier ring, thus ensuring a long working life for the cerumen protector.

The «SmartGuard» protection system with the 15 µm thick diaphragm is bonded to the carrier ring using laser welding.

Laser welding also means that the necessary media resistance of the joint is achieved. The recommended period of use of two months exceeds the period of use of the existing fabric based protection systems. After this period of use, the cerumen protection can easily be replaced using a special tool.

Mask welding

The mask welding process – developed and patented by the Swiss laser system manufacturer Leister Process Technologies and operating on the principle of laser transmission welding – is used for joining the diaphragm to the carrier ring. This involves connecting a joining partner that is transparent to laser radiation with an absorbing joining partner. In the case of the cerumen protection, the diaphragm is transparent to laser radiation. The carrier ring, on the other hand, is made from a thermoplast material which has a fixed shape. It is black in colour and thus absorbs the laser radiation. In the mask welding process used here, a mask is inserted between the laser source (diode laser) and the component. A linear, well collimated – in other words, parallel – laser beam is moved over the parts to be joined. The laser radiation only impinges on the parts to be joined that are not blocked off by the mask. The use of the mask makes it possible to illustrate the finest of structures. This means that mask welding can achieve high levels of precision.



The principle of mask welding. The surfaces located in the shadow of the mask are not irradiated.

This welding concept allows fulfilling a further requirement, namely the need to keep the area for welding to a minimum. This means that there is more area available for the acoustically active diaphragm surface. It is only with the mask welding process that the necessary strength can be achieved with the smallest of welding areas. A further significant advantage is the minimal weld pool depth. The formation of a weld bead can be virtually eliminated. This, in turn, has advantages with regard to dimensional reproducibility and acoustics.

Phonak evaluated various joining processes for this demanding application. The requirements for welding consisted, in general, of the resistance to mechanical and chemical activity. Laser welding had the following advantages when compared with the other processes: No pretreatment of the surfaces, such as plasma irradiation or priming (chemical activation of the surfaces) is required. These would have a negative effect on the foil. Joining processes which produce melting would not be acceptable because of space restrictions.

The high level of reproducibility associated with mask welding has proven to be an advantage over joining processes involving the application of additional materials.

In addition to the process-technological reasons, mask welding also has economical advantages. The consumption of supplies is regarded to be low, when compared with other processes. Batch processing processes, which are carried out semi-automatically and which can be run on plants such as the NOVOLAS WS allow volumes of several millions to be produced in a year. Not least is the advantage that the joining process is even more economical because of the lack of additional material consumption.

Turn-key laser machine NOVOLAS WS for welding plastics.

Prospects

Because of the properties already referred to, the mask welding process is particularly suited to applications in medical technology. In this way foils can be welded onto micro well plates without the melt flowing into the apertures. Mask welding is also recommended for fluidics in general – and for micro fluidic components in particular. This precise and cost-effective process finds applications in products for the entertainment electronics and computer peripherals.

Another process developed by Leister is radial welding. In this process, rotationally-symmetrical parts are welded together without having to move with respect to the laser. In medical technology this process is used for welding catheter attachments. Radial welding also finds applications in sensor technology, fluidics and in the automotive engineering.

The GLOBO welding process, patented by Leister, also finds applications in medical technology. It allows dynamic pressing together of the joining parts, and, for example, it allows two transparent foils to be welded together. The heat energy is transferred to the foils by an absorbent black substrate [which has a melting point which is higher than that of the parts to be joined together]. This concept can be used to join large area components and endless applications.

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