*AirRay® Electrode Technology

With the proprietary *AirRay® electrode technology we have overcome the current limitations for neural electrodes with outstanding mechanical properties and highest manufacturing precision. It also allows very small feature sizes of 25 μm and high integration densities of electrical contacts. The *AirRay® electrode can be designed with variations in thickness, contact size, contact spacing, contact shape and overall electrode size.

By using ultra-short-pulse laser micromachining this technology enables a very high reproducibility. In addition, prototyping of *AirRay® electrodes is very fast. First prototypes can be produced within a day, implantable electrodes require only one week to be manufactured.

The electrodes provide excellent electrochemical properties. By default, Platinum-Iridium is used as electrode material, optionally with high performance coatings for enhanced charge transfer to biological tissue. By varying the thickness of silicone rubber or parylene C reinforcement layers the mechanical properties can be adjusted to individual requirements. Electrodes can, thus, be very soft or hard enough to be pushed under the skin or into fascicular tissue.

The electrode can be modified for example to build three-dimensional assemblies as well as nerve cuff electrodes that wrap around peripheral nerves. Further adaptations cover the integration of microfluidic channels for drug delivery into electrode arrays. It is, furthermore, possible to fold planar *AirRay® electrodes or to establish combinations with other technologies.

*AirRay® Cortical Electrode (see following page) is cleared for clinical use by FDA.
°AirRay® Cortical Electrode

°AirRay® Cortical Electrode has received market clearance from the Food and Drug Administration (FDA) in the USA for invasive neuromonitoring in the central nervous system. The product portfolio includes all possible contact arrangements from 1×4 to 8×8 electrode contacts.

In the following we list the designs that we offer as part of our standard catalogue. Please contact us for other configurations.

**Strip-Electrodes**

1x4 Strip Electrode | 4 Contacts

1x6 Strip Electrode | 6 Contacts

1x8 Strip Electrode | 8 Contacts

**Grid-Electrodes**

2x4 Grid Electrode | 8 Contacts
Product Information °AirRay® Electrodes

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4x8 Grid Electrode | 32 Contacts

6x8 Grid Electrode | 48 Contacts

8x8 Grid Electrode | 64 Contacts
DESIGN OPTIONS

Multi-Layer Functionalization
• Adjustment of thickness and flexibility by number and type of polymer or metal layers
• Adaptation of contact density and functionality by number and type of metal layers
• Integration of microfluidic channels and ports

General Dimensions
• Thickness:
  • Silicone electrodes: 0.15 mm – 1 mm
  • Hybrid silicone-parylene electrodes: 0.08 mm – 1 mm
• Contact size:
  • Silicone electrodes: down to 0.1 mm
  • Hybrid silicone-parylene electrodes: down to 0.05 mm
• Contact spacing:
  • Silicone electrodes: down to 0.3 mm center-to-center
  • Hybrid silicone-parylene electrodes: down to 0.06 mm center-to-center
  Depending on number of contacts
• Contact shape: round, rectangular or arbitrary
• Design geometry maximum: 90 mm x 90 mm
• Various designs for electrode outline incl. slit contours

Design Variation – Cuff Electrodes
• Inner diameter: starting from 0.1 mm
• Number of contacts: arbitrary
• Closing mechanisms:
  • Split cylinder
  • Buckle-and-belt
  • Self-spiraling
  • Piano hinge
• Further closing mechanisms for chronic implantation can be developed

Other Variations
• Folding planar AirRay® electrodes
• 3D assembly of multiple AirRay® electrodes
• Intrafascicular electrodes
• Combination with other technologies:
  • Depth electrodes
  • 3D metal parts
  • Functional components such as surgical mesh or suture material
MATERIALS

<table>
<thead>
<tr>
<th>Polymers</th>
<th>Metals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical grade silicone rubber</td>
<td>Medical grade metal alloys:</td>
</tr>
<tr>
<td></td>
<td>• Platinum–Iridium (90/10)</td>
</tr>
<tr>
<td></td>
<td>• Platinum</td>
</tr>
<tr>
<td></td>
<td>• MP35N</td>
</tr>
<tr>
<td></td>
<td>High-performance coatings:</td>
</tr>
<tr>
<td></td>
<td>• Sputtered Iridium Oxide (SIROF)</td>
</tr>
<tr>
<td></td>
<td>• Platinum Black</td>
</tr>
<tr>
<td>Parylene–C</td>
<td>Physical surface modification permits additional adaptations to the individual application.</td>
</tr>
</tbody>
</table>

PERFORMANCE

<table>
<thead>
<tr>
<th>Charge Injection Capacity</th>
<th>Impedance (Diameter 1 mm)</th>
<th>Impedance (Diameter 2.7 mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10 Hz</td>
<td>1 KHz</td>
</tr>
<tr>
<td>MP35N</td>
<td>Max. 0.03 mC/cm²</td>
<td>260 kΩ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 kΩ</td>
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<td></td>
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<td>32 kΩ</td>
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<tr>
<td></td>
<td></td>
<td>0.6 kΩ</td>
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<tr>
<td>Platinum–Iridium (90/10)</td>
<td>0.09 mC/cm²</td>
<td>47 kΩ</td>
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<tr>
<td></td>
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<td>1 kΩ</td>
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<td>8 kΩ</td>
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<tr>
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<td></td>
<td>0.2 kΩ</td>
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<tr>
<td>Platinum</td>
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<tr>
<td>Sputtered Iridium Oxide (SIROF)</td>
<td>≥ 1 mC/cm²</td>
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</tr>
<tr>
<td>Platinum Black</td>
<td>0.25 mC/cm²</td>
<td>available on request</td>
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</table>

TESTING

- Impedance spectroscopy
- Pulse testing
- Corrosion testing
- Reliability testing
VALIDATIONS

Our development and manufacturing comply with highest quality standards. We can offer a wide range of in-house validations or verifications as well as validations together with partners and test laboratories. The listed validations concern all of our products, their developing and manufacturing stages.

Process Validations (together with external partners and test laboratories)
• Cleaning process validation
• Packaging process validation
• Sterilization process validation (ETO)

Mechanical and Electrical Validations/Verifications
• Design and product specifications
• Bending load
• Tensile testing
• Micro IRHD testing (together with external partners)
• Impedance
• Dielectric strength
• Corrosion
• Layer pull strength
• Hermeticity
• Shear strength

GENERAL SERVICE

For all our °AirRay® Electrodes we offer the following services:
• Device design
• Tests/validations of new designs incl. technical documentation
• Sterilization
• Cleaning