

Product Developments

Multitrode – the One-for-all-Purposes Electrode

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To get good EEG signals it has been necessary to reduce the skin-to-electrode impedance. The better the signal from the brain to the electrode the less noise from other sources is contained in the recorded signal. Impedance is minimized most effectively by degreasing and mechanical abrasion of the outermost skin layers. With 64, 128, or more electrodes, this becomes an increasingly time-consuming task.

The easiest way to save time is not to do the impedance minimization. Thus a number of technical developments aim at achieving lower noise levels despite high skin-to-electrode impedances. These measures include amplifiers with input-impedances in the megohm range or active electrodes on the electronic side, and advanced filter techniques or analysis methods like ICA or template-matching on the data-processing side. On the sensor side, projects have been tried using dry electrodes without gel or wet electrodes with only salty liquids.

These measures can bring signal quality to a level which is sufficient for some applications, but even in combination, they do not reach the signal quality and data reliability of classic passive electrodes mounted with impedance levels of 5 kOhm or less. Furthermore, some of these measures like active electrodes cannot be used in EEG recordings with other techniques such as fMRI or MEG.

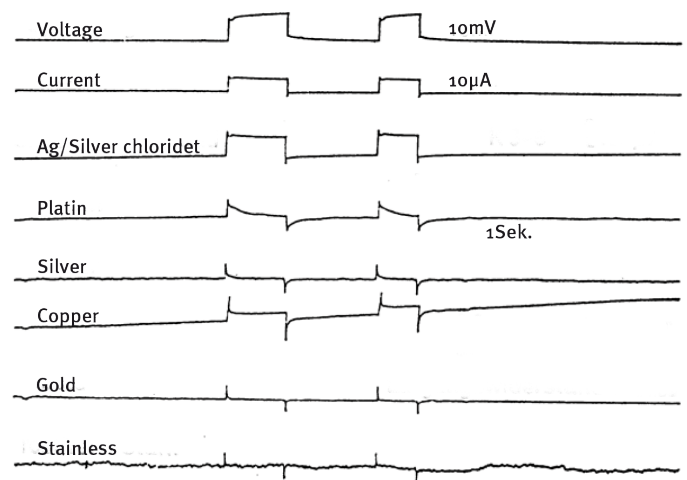
Thus, when the data of interest are very small or easily obscured, when it is necessary to exclude as many confounding factors as possible, or when there are technical obstacles, the use of passive electrodes at low impedances is still the best choice.

To these users and applications we can now introduce a new electrode shape, the Multitrode.

The Multitrode is long-living, it allows for as easy, painless, and effective impedance minimization as possible, and it can be used on skin, in hair, or in caps.

Multitrode: Materials

The sensor material is sintered Ag/AgCl. This is the only sensor material that reproduces quick and slow changes of the signal amplitude truthfully, and so it can be used for the entire frequency range from DC to brain stem potentials.



Sintered Ag/AgCl needs no re-chloriding, the Cl-ions do not leave the sensor, and the electrodes are non-polarizable. The sensor is massive, not plated, and so it is not damaged by abrasive materials or by cleaning.

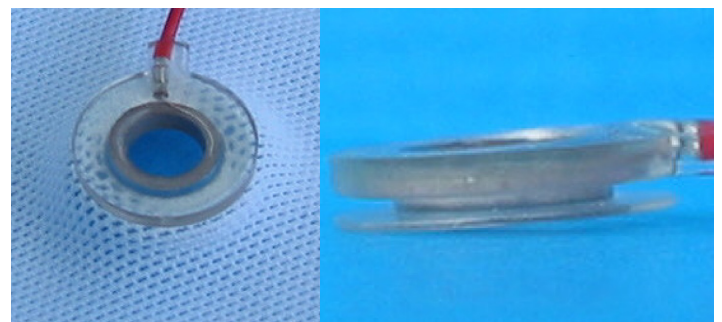
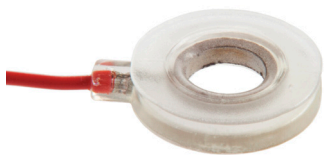
The sensor and the cable are sealed into the housing by a special resin, making the whole ensemble water-tight. All materials can be disinfected.

The cable has very flexible tinsel wire as conductor. The insulation is extremely tough. Electrode cables often break where the flexible cable enters the housing, so this will elongate the life-span significantly.

Multitrode: Mounting

The Multitrode has a flat contact surface without sensor material, so it can be attached to bare skin by washers (double-sided adhesive rings), or glued into hair with conductive paste. The outer groove means it can be buttoned into the slits of a cap (see picture below). The very flat profile of less than 3.5 mm makes the electrode comfortable to lie on.

The large central opening makes it possible to do all skin



treatment and gel-filling after the electrode has been fixed to the skin or the cap has been put on. Especially in the case of washers this means that the electrode is fixed to dry, clean skin with no gel present. Thus any EOG- or ECG-electrode will be secured reliably and will not be in danger of falling off.

Multitrode: Easy Impedance Minimization

For optimal impedances, the skin must be free of grease and other isolating materials such as shampoo conditioners, the outermost ceratinized skin layers must be removed, the contact area between gel and skin must be as large as possible (several square millimetres), and the contact between skin and electrolyte gel (or paste) and between gel and sensor surface must be good.

The Multitrode simplifies achieving these goals by its ring shape with a central opening of 6 mm diameter, where the inside walls are made of the Ag/AgCl sensor material:

- the 6mm-opening is large enough to comb aside the hair underneath, e.g. with the wooden end of a cotton swab. This ensures that the skin is visible and accessible, so that the following steps can be performed on the skin purposeful and controlled – you see what you're doing.
- degreasing (unless subjects arrive with freshly washed hair) of the skin can be done with an alcohol-soaked cotton swab through the opening.
- abrasion too can be done by twirling a cotton swab dipped in abrasive gel on the skin. This method is extremely effective, it needs no pressure, only speed, and so does not hurt or leave reddening or even scurf.
- if an abrasive electrolyte gel has been used then the work is already done: the twirling has pressed the electrolyte into the skin and along the inner walls of the sensor cylinder. Impedances and contact will be fine by now and only for reliability a little more gel can be filled in.

Keep in mind that what is described here is a careful and elaborate way to reliably achieve impedances below 5 kOhm, when they are needed. Even so, using Multitrodes will accelerate your prepping time compared to former ring-shaped electrodes. For most subjects it will be enough to only do the abrading with a little subsequent filling. As a result, we are in a time-range for cap mounting comparable to scratching and filling with blunted needle, but we get there painlessly and end up with better and more consistent impedances.

Multitrode: Variants and Caps

The Multitrode is a very versatile electrode that can be used for many applications in EEG, or as ECG- or EOG-electrodes, for EMG, or GSR. We can supply the Multitrode in many different realisations.

The basic Multitrode is available

- in any cable length (please specify)
- with heavy-duty lead wire (recommended for single electrodes)
- with light-duty lead wire (recommended for bundled or fixed electrodes as in caps)
- with 1.5mm-touchproof safety sockets (the most common type)
- or with other single connectors (please specify)
- or as cable-tree where many electrodes are terminated on multi-channel connectors

If required we can equip the Multitrode with micro-coax-connectors or separate Gnd-connector and

- heavy-duty shielded cable, or
- light-duty shielded cable

For recordings simultaneous with other techniques, available specialized types are

- Multitrodes for TMS
- Multitrodes for fMRI
- Multitrodes for MEG

We will use the Multitrode in all EEG recording caps where the electrodes are built-in permanently (or at least are meant to stay at the same site for long periods) under the generic term "BrainCap". The other cap family with detachable, single electrodes is the "EasyCap".

Beside customized caps, the following BrainCaps are available in Standard Versions:

- **Standard BrainCap with Multitrodes** for normal EEG/ERP without other simultaneous techniques with 22, 32, 64, 96, or 128 channels
- **Standard BrainCap MR** with 32, 64, 96, or 128 channels
- **Standard BrainCap for TMS** with 21, 32, 64, or 128 channels
- **Standard BrainCap for MEG** with 23, 32, 64, or 128 channels

In addition to this new and optimized way to perform classic research EEG with low impedances and passive electrodes, we also have other types of electrodes/caps and recommend them where advantageous. We know that the variety of methods and applications together with the numerous hardware and technical affordances makes choosing the appropriate electrode/cap a tedious distraction from a scientist's goals. But for us this is our daily work, and we invite you to contact us for further information or details at info@easycap.de. ●