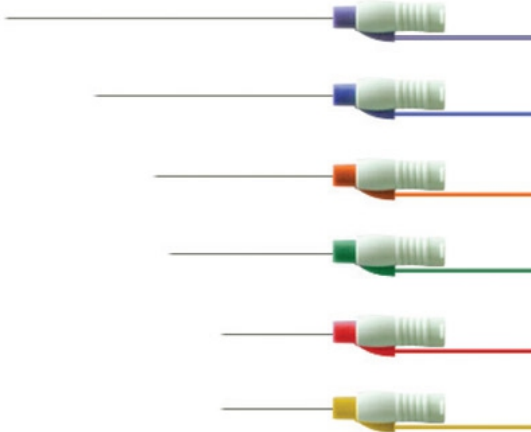
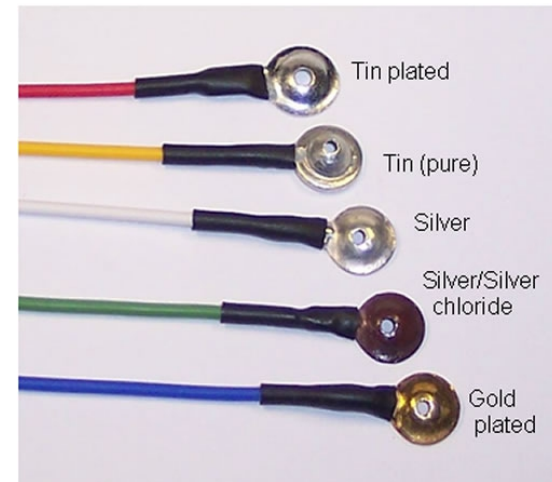
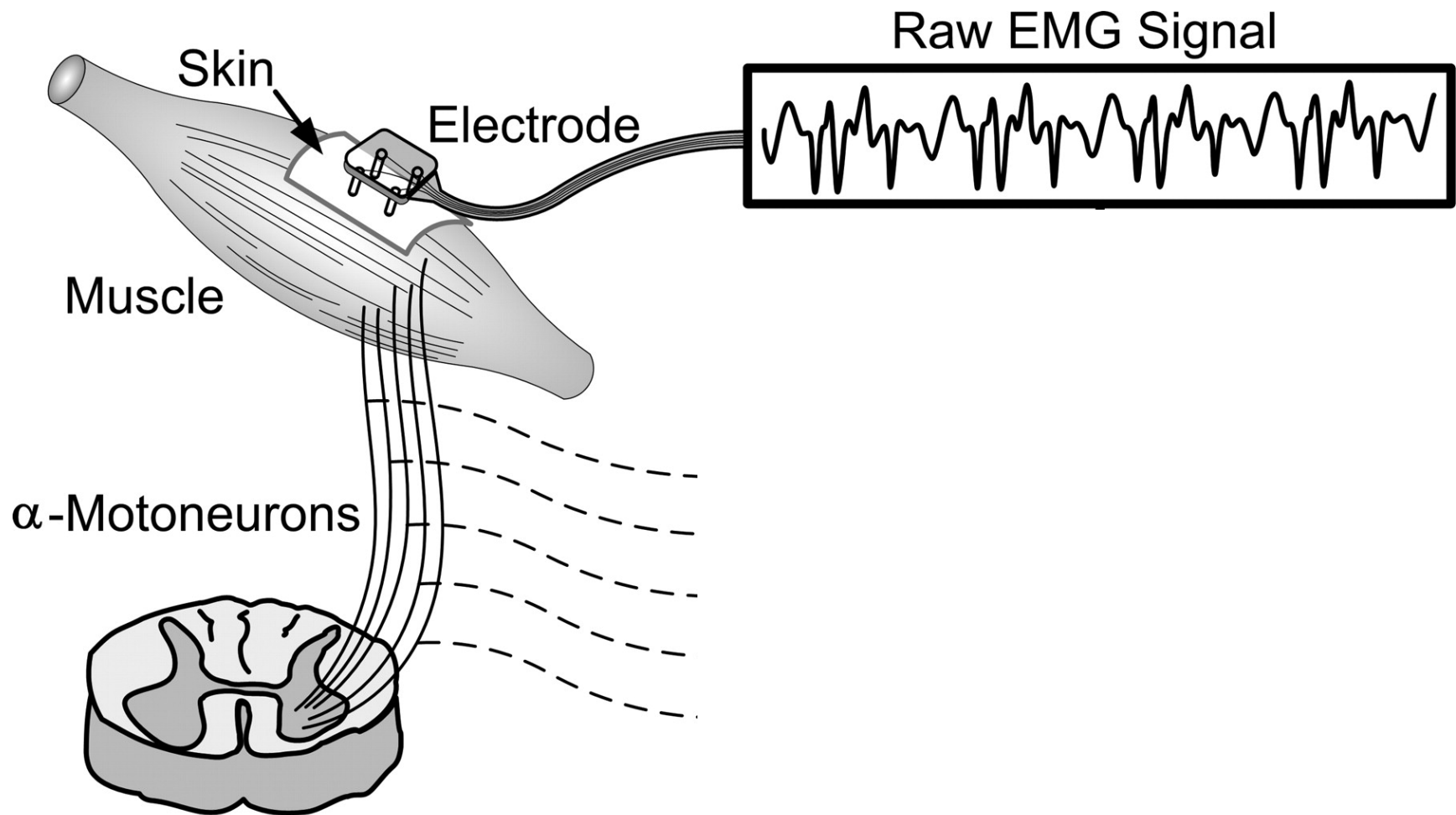


# Eletrodos de captação de biopotenciais

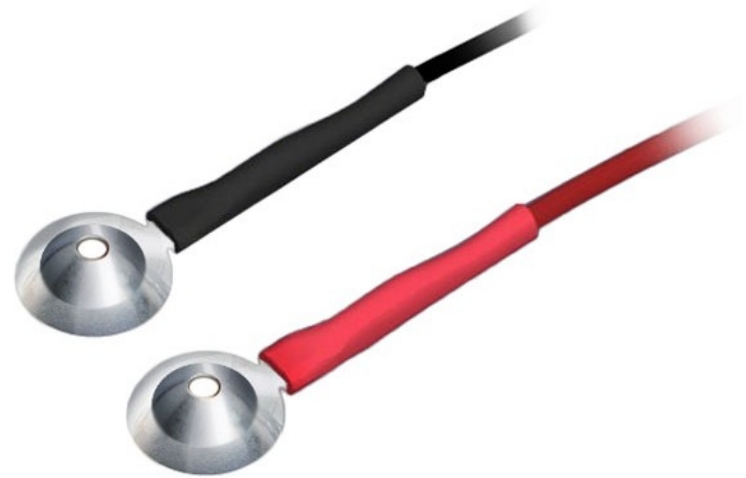


# Eletrodos de captação de biopotenciais



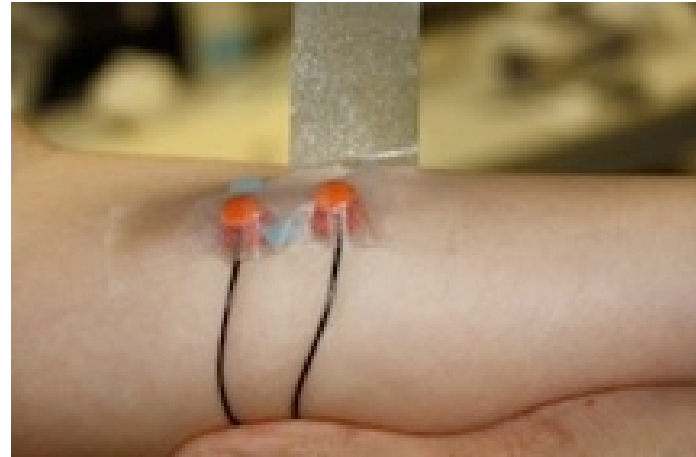
# Tipos

## - Eletrodos não invasivos:



# Tipos

## - Eletrodos não invasivos:



# Tipos

## - Eletrodos não invasivos ativos:



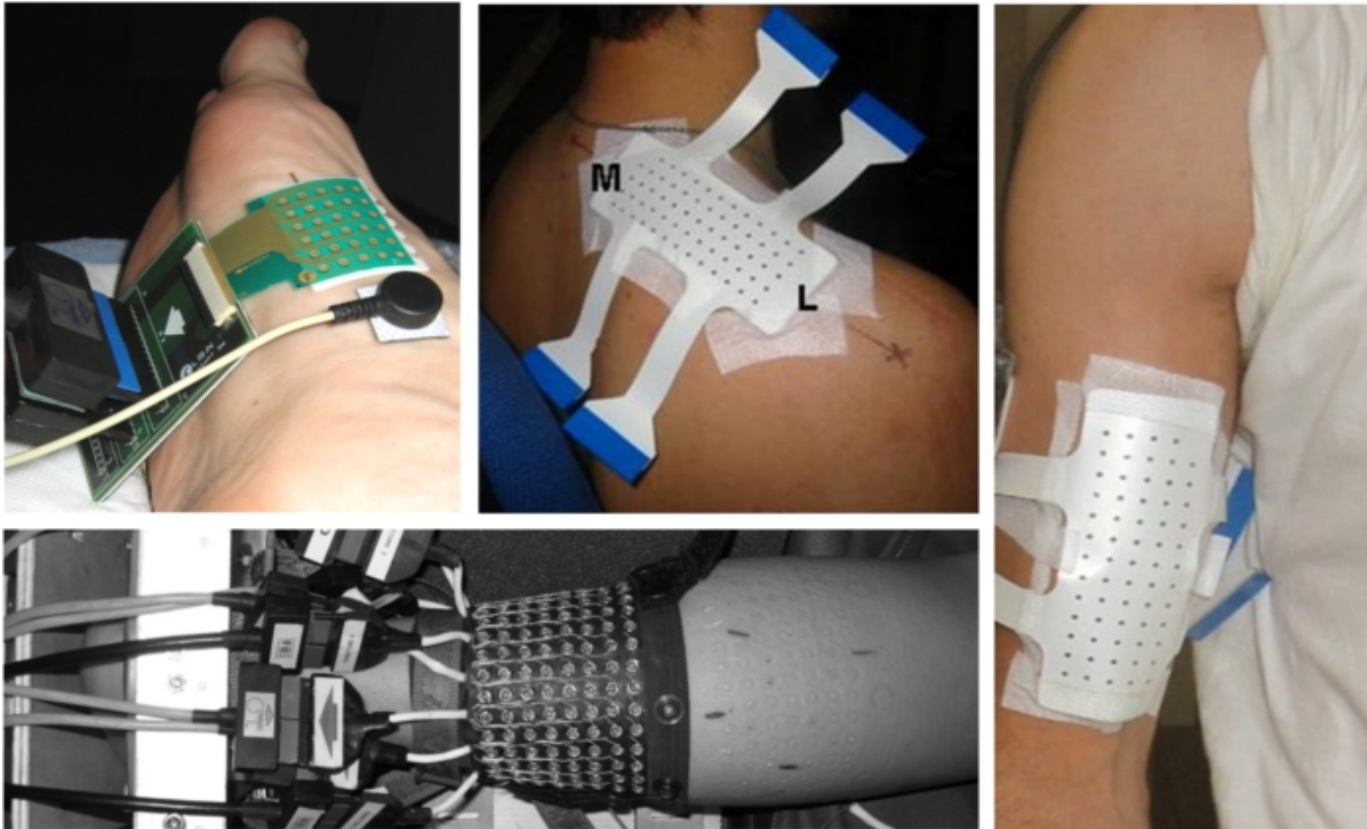
# Tipos

## - Eletrodos não invasivos capacitivos:



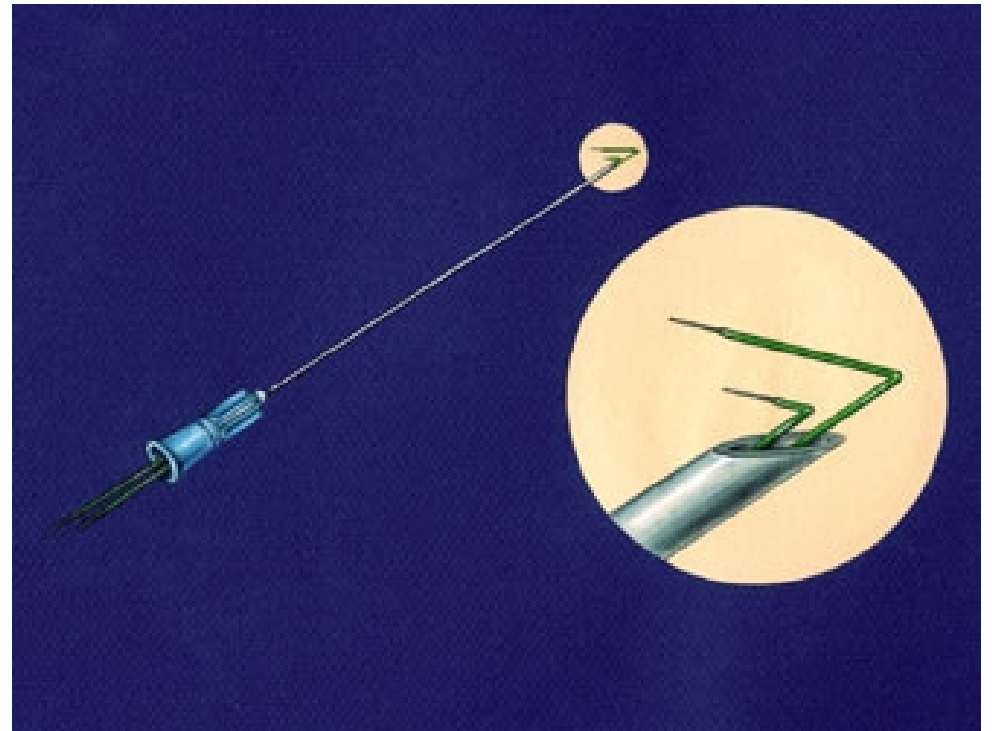
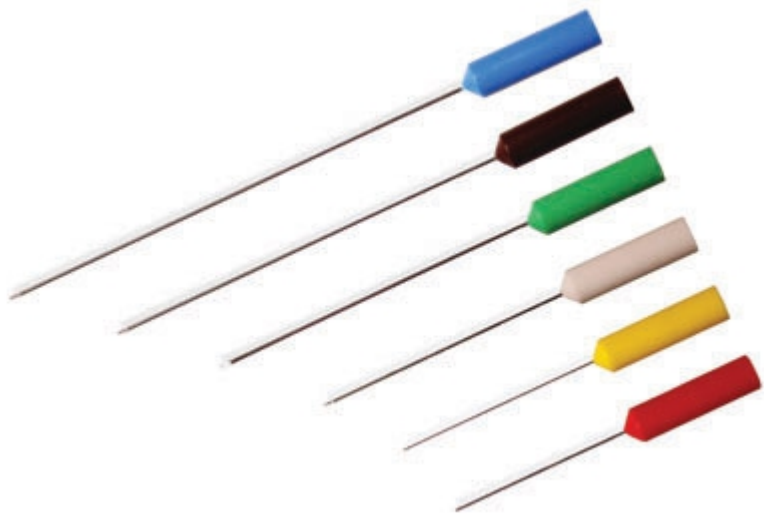
# Tipos

## - Eletrodos não invasivos em array:



# Tipos

## - Eletrodos invasivos:





# Tipos

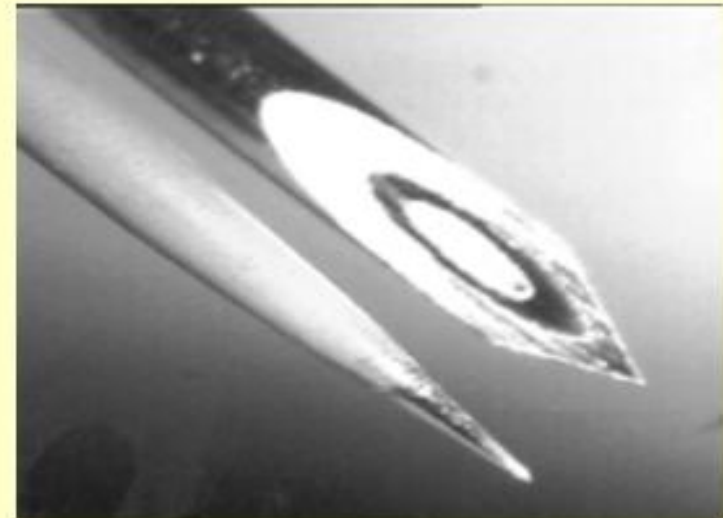
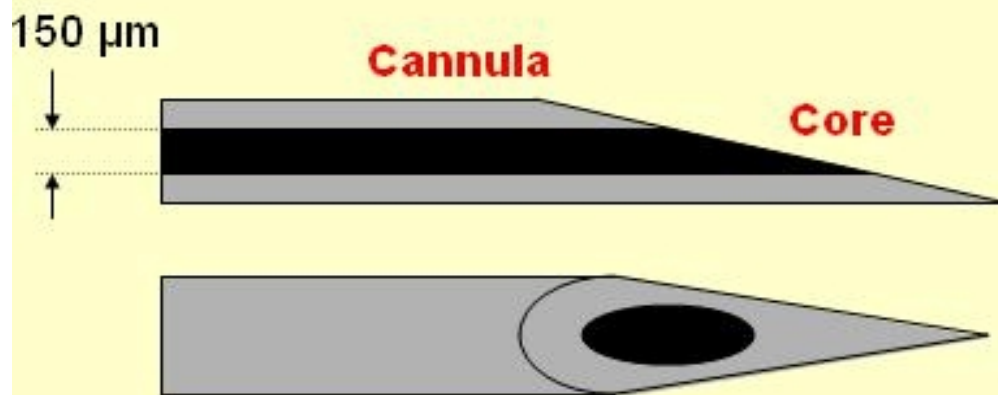
## - Eletrodos invasivos:



# Tipos

## - Eletrodos invasivos:

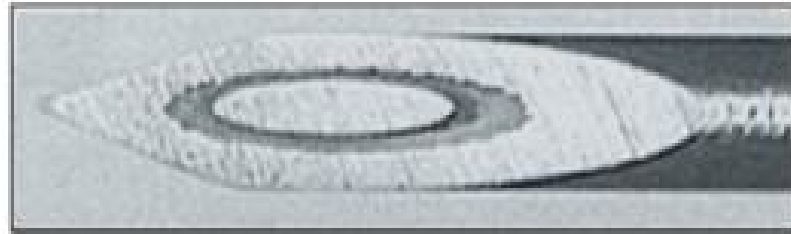
### Concentric Needle Electrode



# Tipos

## - Eletrodos invasivos:

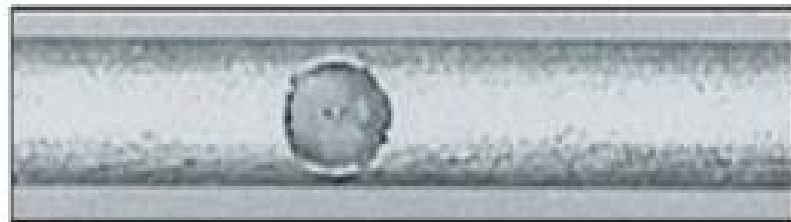
Concentric  
 $0.07 \text{ mm}^2$



Monopolar  
 $0.34 \text{ mm}^2$



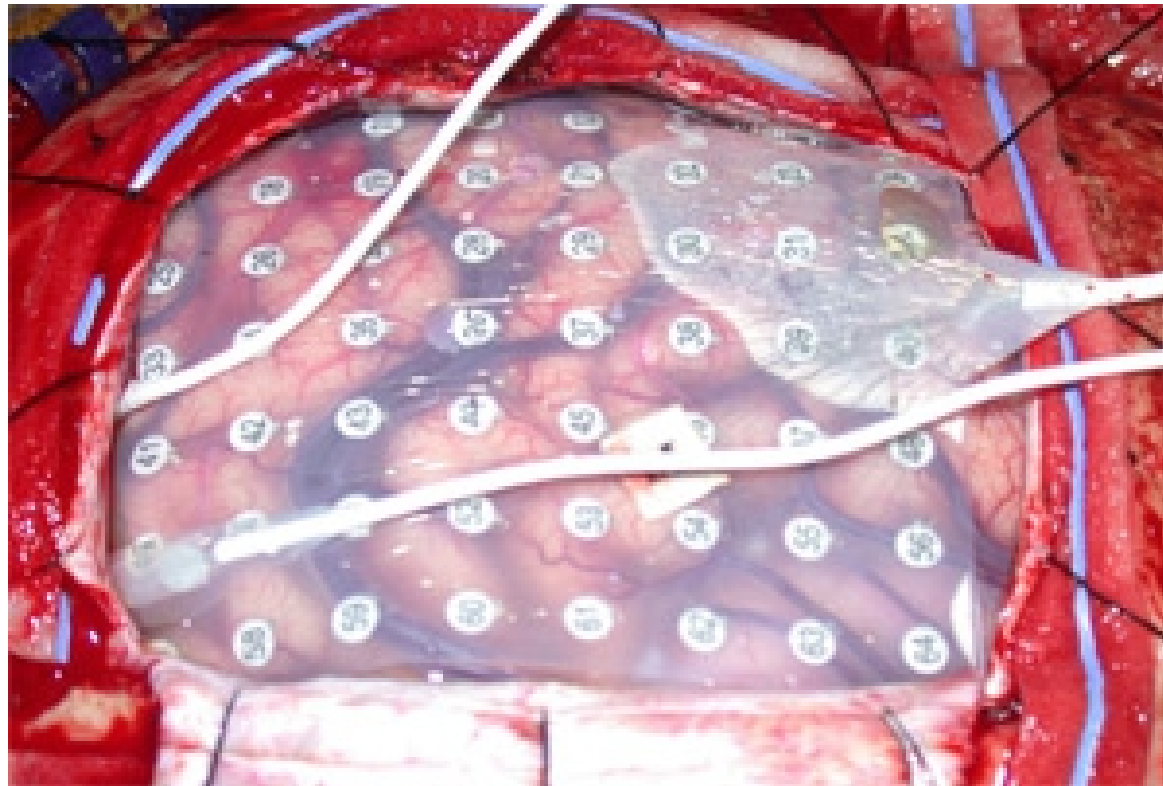
Single fiber  
 $0.0005 \text{ mm}^2$



1 mm

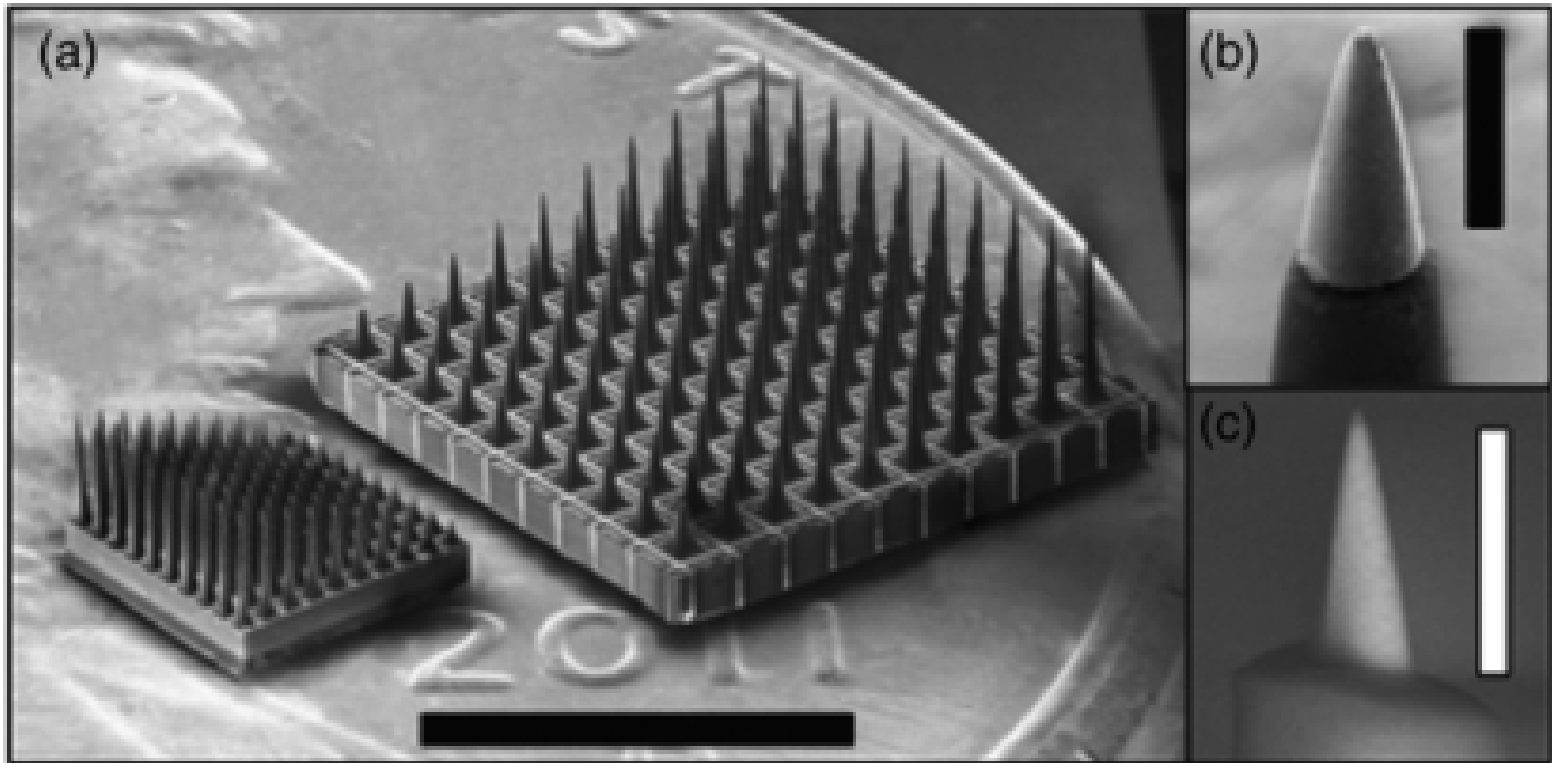
# Tipos

## - Eletrodos invasivos:



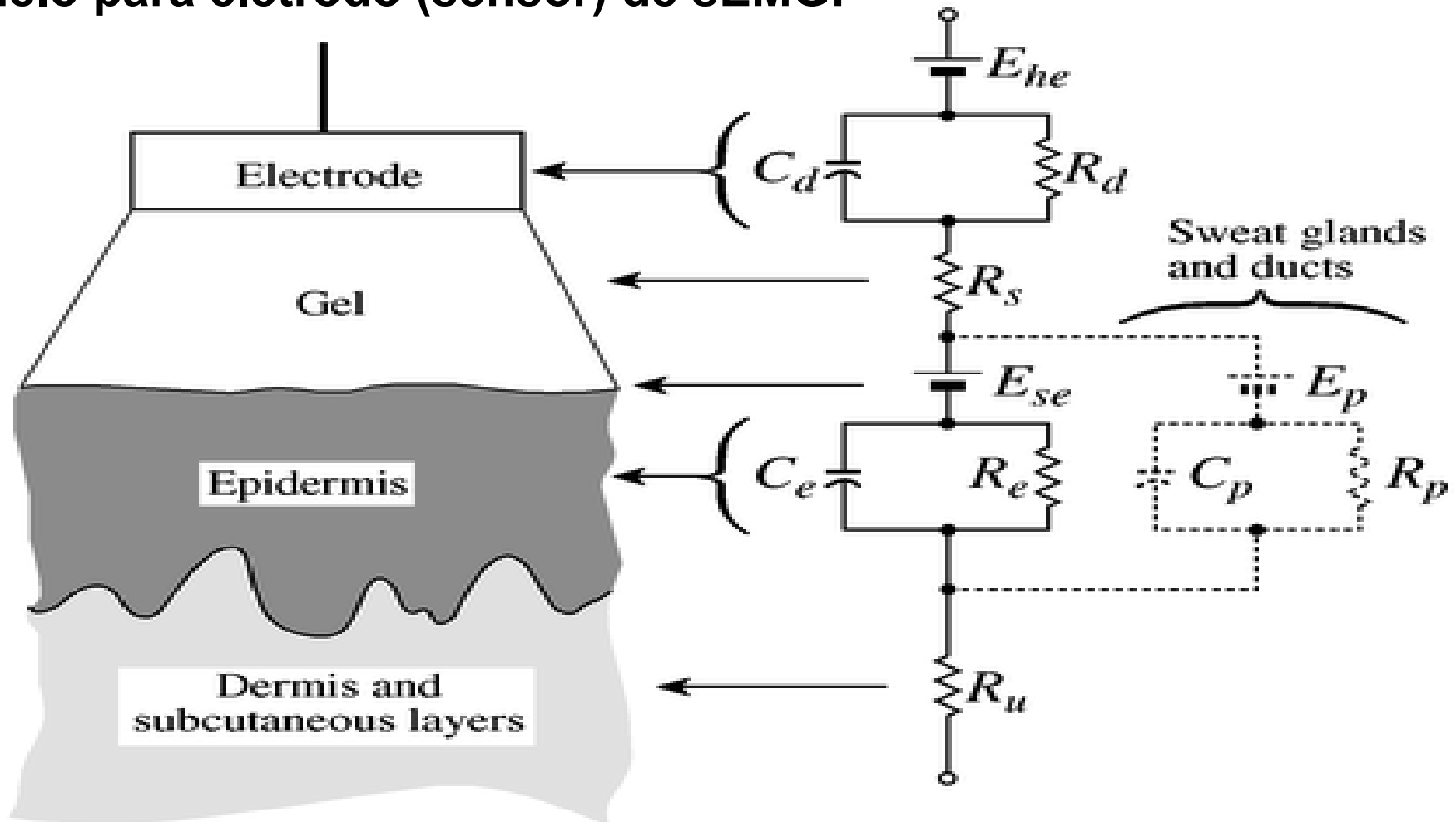
# Tipos

## - Eletrodos invasivos array:



# Comportamento elétrico

- Modelo para eletrodo (sensor) de sEMG:



# Comportamento elétrico

## - Potencial de meia célula

**Table 5.1** Half-cell Potentials for Common Electrode Materials at 25 °C

The metal undergoing the reaction shown has the sign and potential  $E^0$  when referenced to the hydrogen electrode.

Metal and Reaction	Potential $E^0$ , V
$\text{Al} \rightarrow \text{Al}^{3+} + 3\text{e}^-$	-1.706
$\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^-$	-0.763
$\text{Cr} \rightarrow \text{Cr}^{3+} + 3\text{e}^-$	-0.744
$\text{Fe} \rightarrow \text{Fe}^{2+} + 2\text{e}^-$	-0.409
$\text{Cd} \rightarrow \text{Cd}^{2+} + 2\text{e}^-$	-0.401
$\text{Ni} \rightarrow \text{Ni}^{2+} + 2\text{e}^-$	-0.230
$\text{Pb} \rightarrow \text{Pb}^{2+} + 2\text{e}^-$	-0.126
$\text{H}_2 \rightarrow 2\text{H}^+ + 2\text{e}^-$	0.000 by definition
$\text{Ag} + \text{Cl}^- \rightarrow \text{AgCl} + \text{e}^-$	+0.223
$2\text{Hg} + 2\text{Cl}^- \rightarrow \text{Hg}_2\text{Cl}_2 + 2\text{e}^-$	+0.268
$\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^-$	+0.340
$\text{Cu} \rightarrow \text{Cu}^+ + \text{e}^-$	+0.522
$\text{Ag} \rightarrow \text{Ag}^+ + \text{e}^-$	+0.799
$\text{Au} \rightarrow \text{Au}^{3+} + 3\text{e}^-$	+1.420
$\text{Au} \rightarrow \text{Au}^+ + \text{e}^-$	+1.680

SOURCE: Data from *Handbook of Chemistry and Physics*, 55th edition, CRC Press, Cleveland, Ohio, 1974–1975, with permission.

# Comportamento elétrico

## - Polarizáveis:

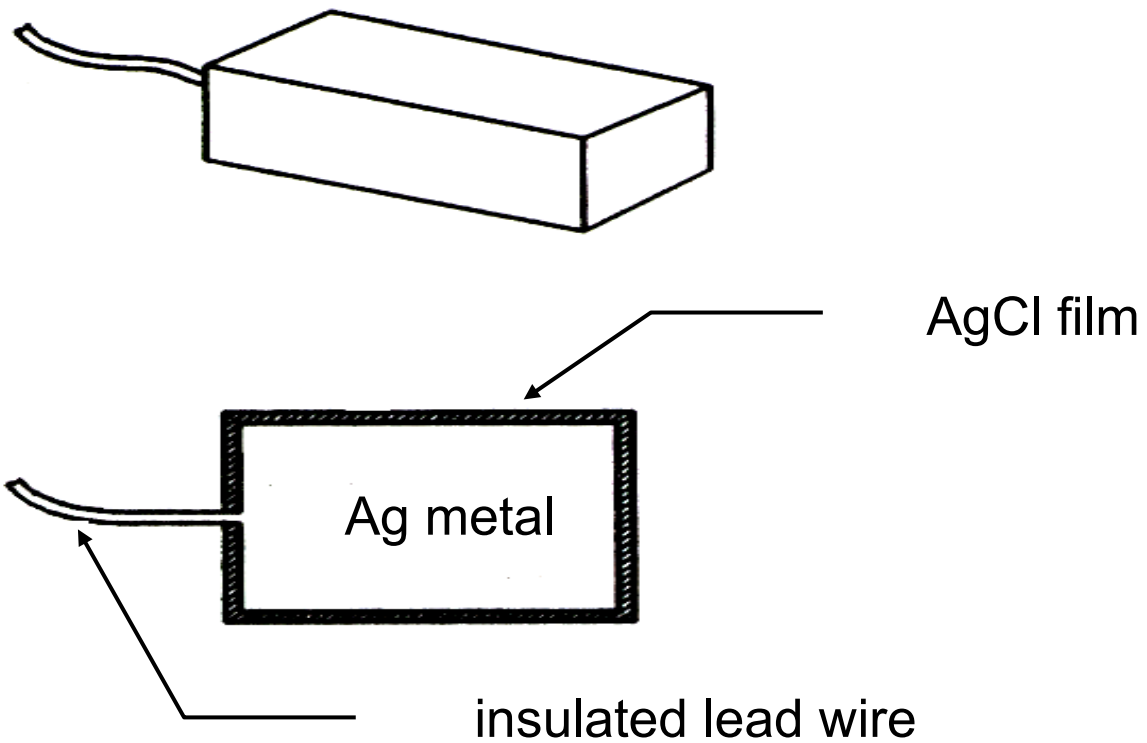
- Não ocorre reação de oxi-redução na interface eletrodo/eletrólito
- Acoplamento capacitivo
- Atenuação de baixas frequências
- Situação dos Eletrodos invasivos

## - Não polarizáveis

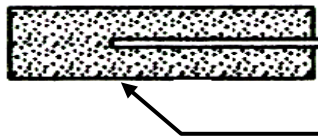
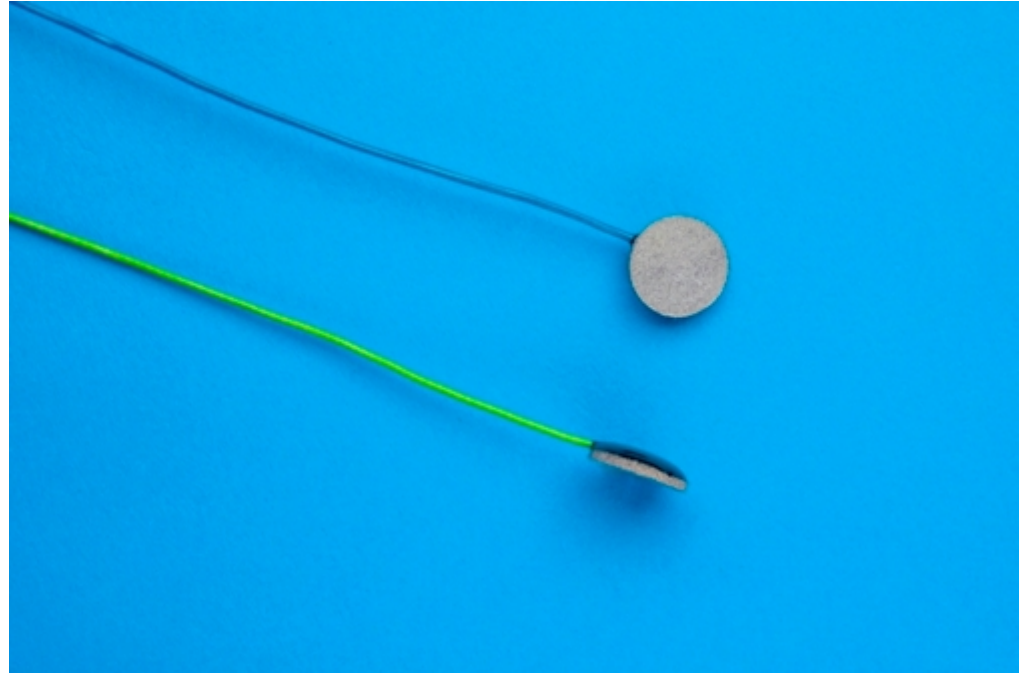
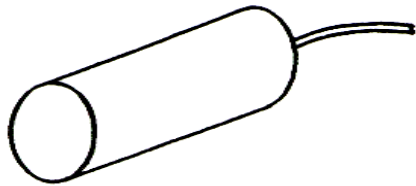
- Permitem a livre passagem de íons/elétrons na interface eletrodo/eletrólito
- Eletrodos Ag/AgCl



# Eletrodo Ag/AgCl



# Eletrodo Ag/AgCl



Ag lead wire  
sintered Ag and AgCl  
(Ag and AgCl powder mechanically pressed)

# Eletrólito

- Gel pastoso com Ânion Cl (levemente hipertônico)



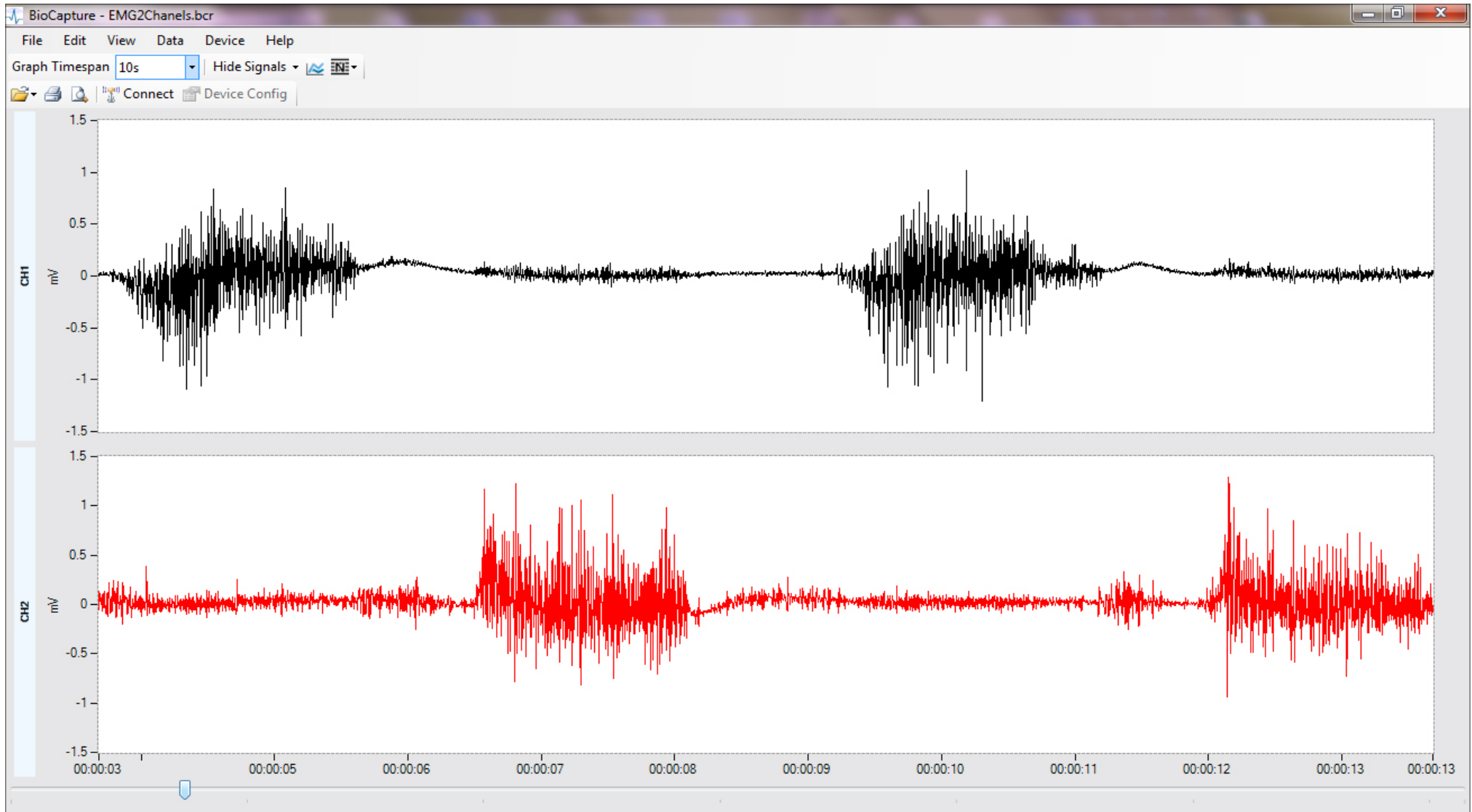
# Preparação da pele

## - Gel esfoliante

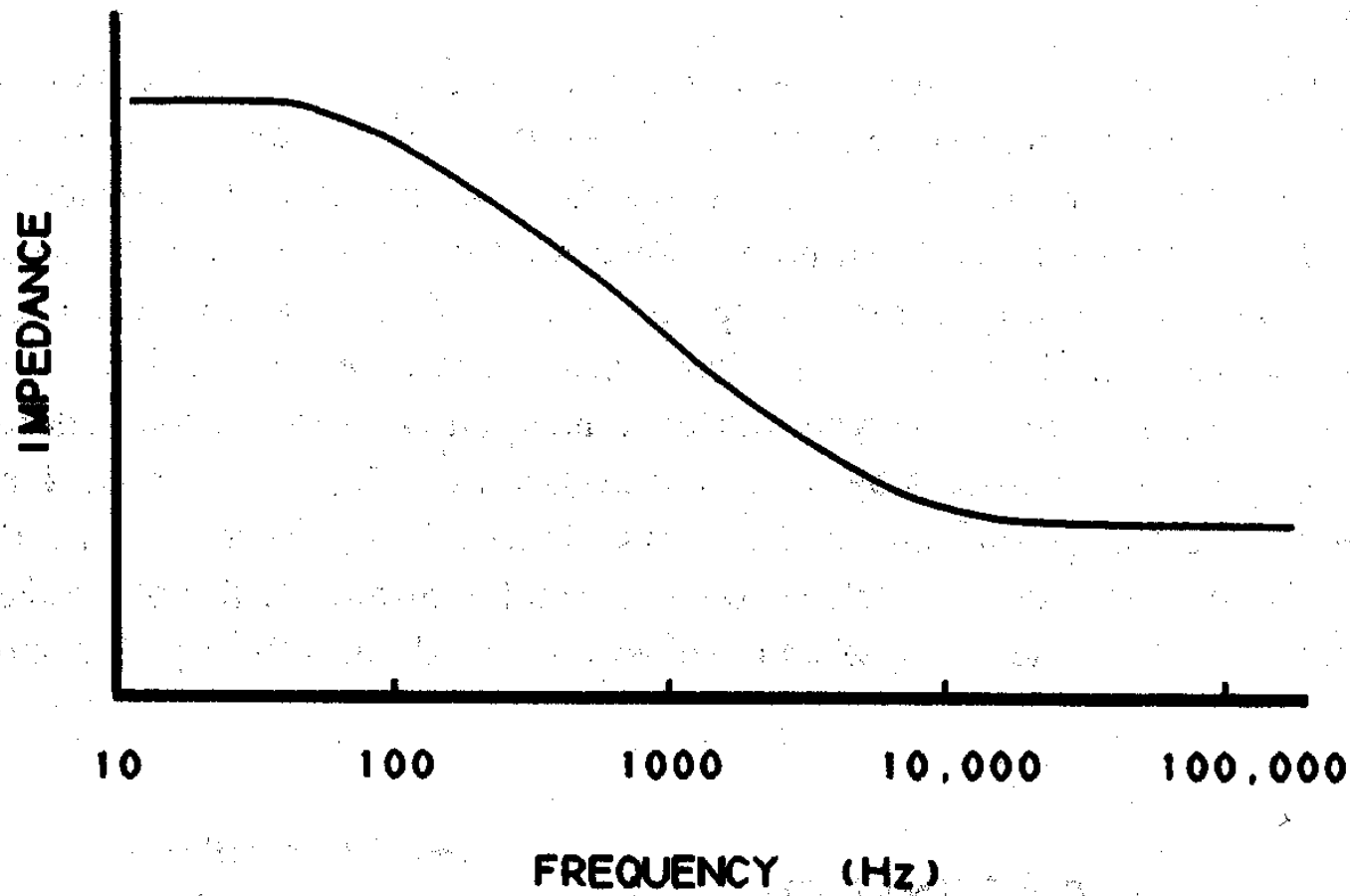


**NO  
ALCOHOL**

# Artefato de movimento



# Resposta típica em frequência Ag/AgCl

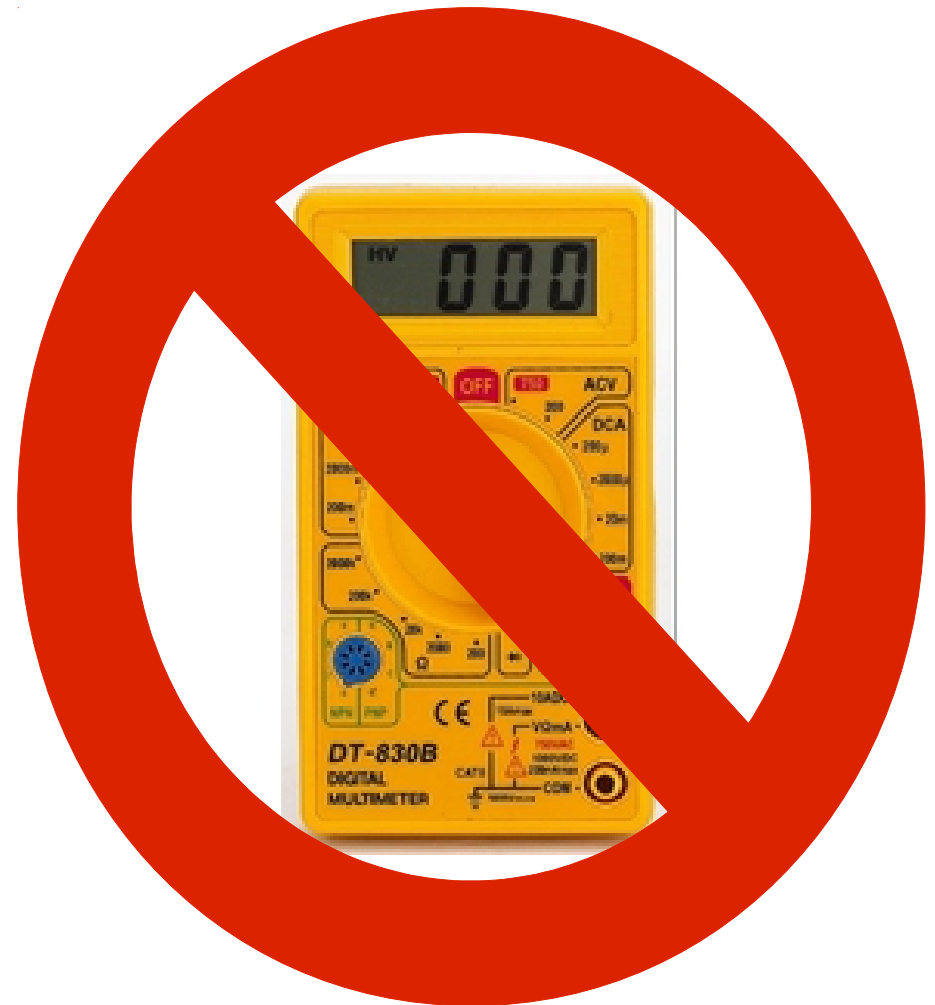


# Tensões a serem medidas

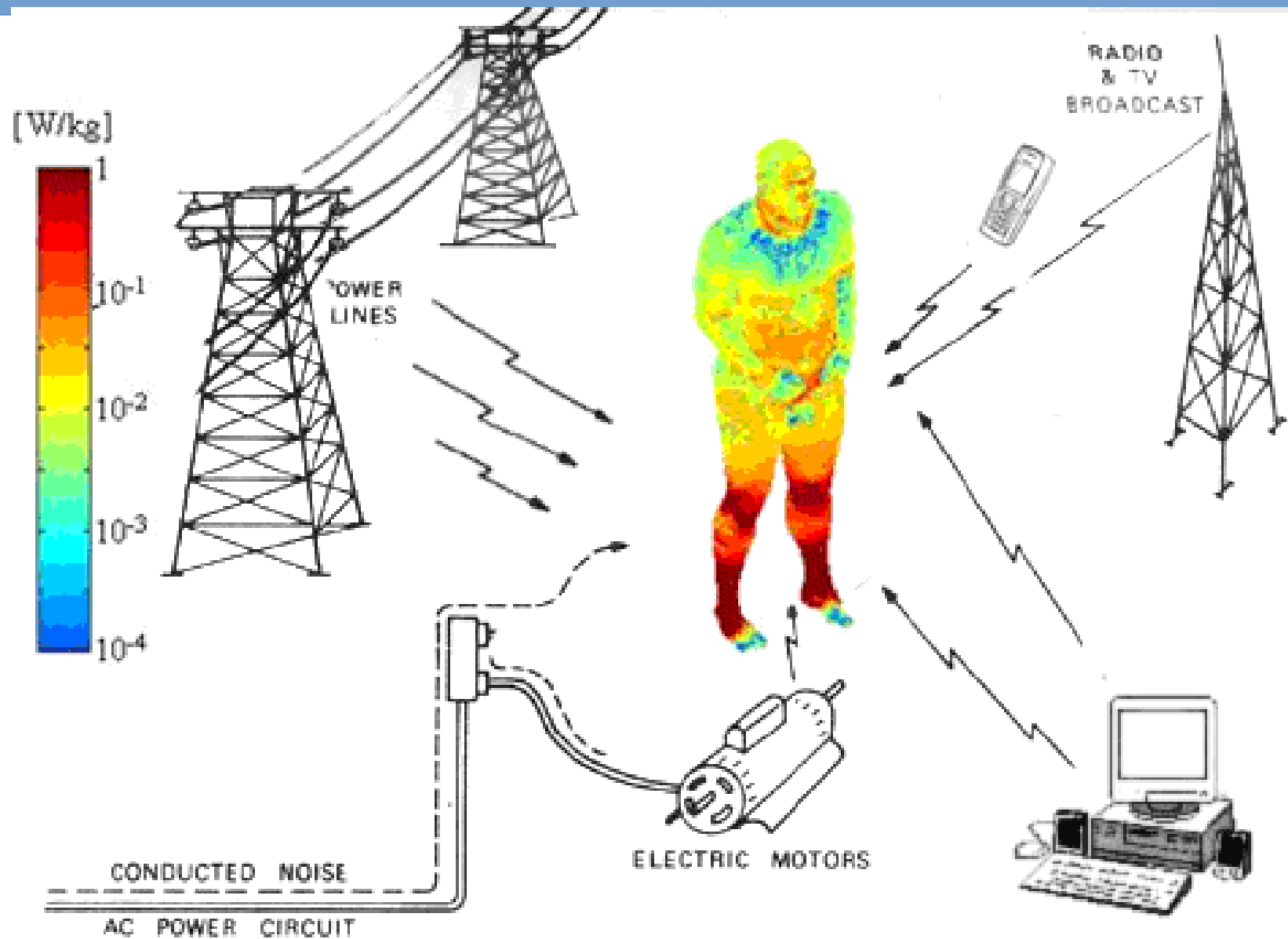
**sEMG – 0 – 10 mV**

**ECG – 1- 5mV**

**EEG - – 10 - 100uV**



# Interferência





# Eletrodos de captação de biopotenciais

## Referências:

- Muscles Alive: Their Functions Revealed by Electromyography by John V. Basmajian (Author), Carlo J. De Luca (Author)
- Medical instrumentation Application and Desing, Jhon G. Webster
- Electromyography: Physiology, Engineering, and Non-Invasive Applications, Roberto Merletti (Editor), Philip J. Parker (Editor)
- Slides de Dimitar Stefanov:  
[http://web.cecs.pdx.edu/~mperkows/Rehabilitation\\_Robots/lecture7.ppt](http://web.cecs.pdx.edu/~mperkows/Rehabilitation_Robots/lecture7.ppt)