

Step Response of Metal Electrodes

Presentation to the International Conference on
Spreading Depolarization
11-17 November, 2024

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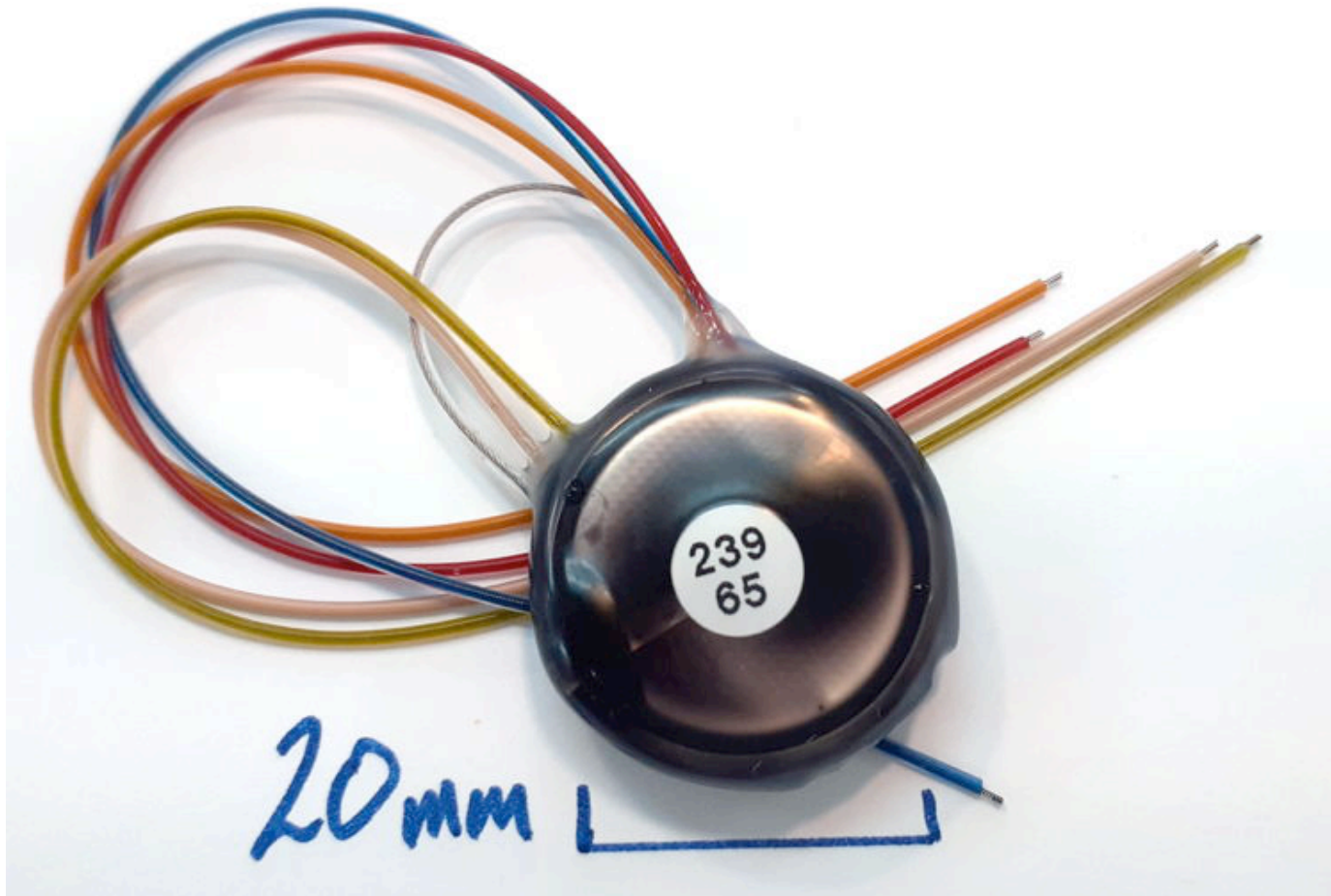


Introduction

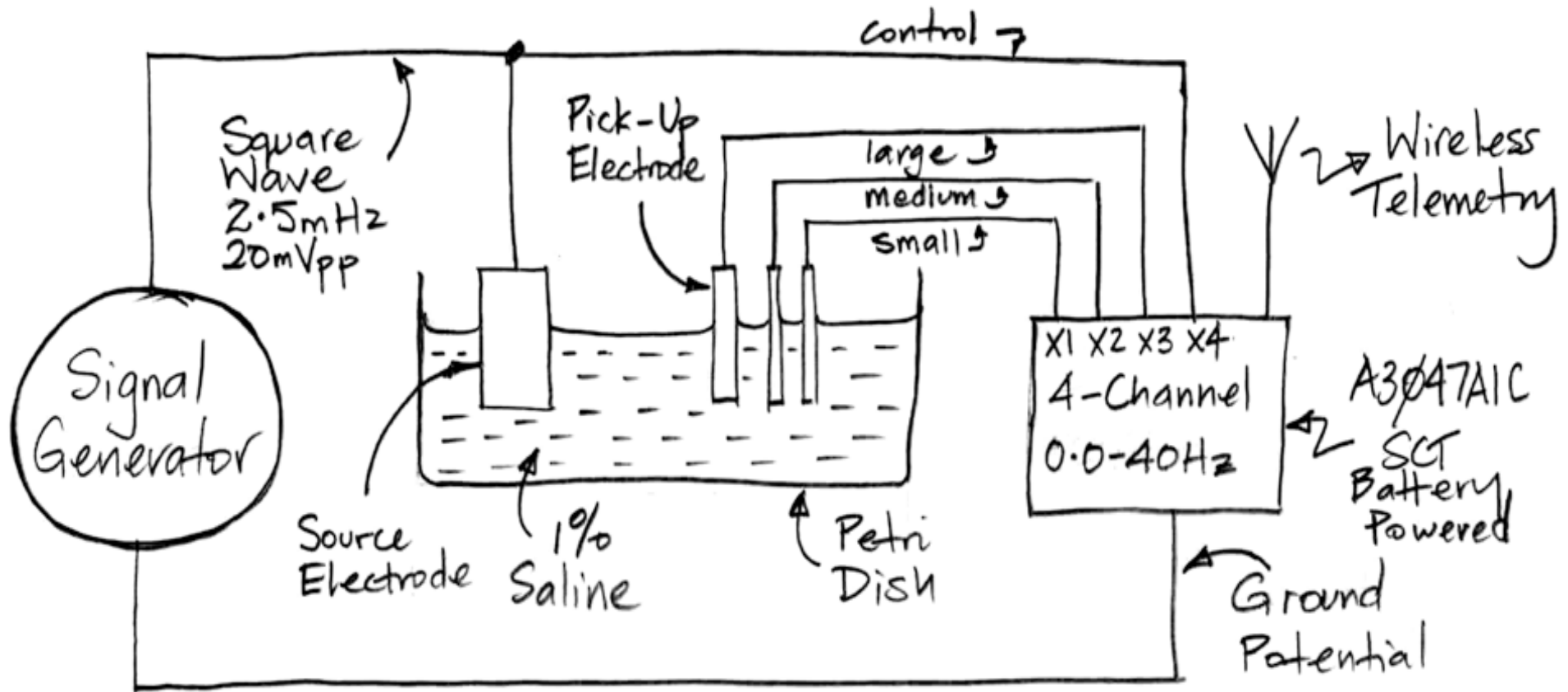
- OSI manufactures implantable ECoG sensors for rats and mice.
- First used to record SDs in 2018 (Dr. Robert Wykes, ION/UCL).
- Those devices equipped with 316SS electrodes.
- The 316SS electrodes report SD amplitude 3 mV.
- But intracortical glass electrodes report SD amplitude 20 mV.
- How does choice of electrode metal affect recorded amplitude?
- How does electrode surface area affect recorded amplitude?
- Do some metals generate more potential drift than others?
- We recorded 0.0025-Hz, 20-mV square waves with a variety of metals immersed in saline.
- Want to identify best metal for recording SDs with implantable sensors.

Methods: Voltage Sensor

- Battery-powered sensor eliminates 60-Hz noise.
- Dynamic range 120 mV. Passband DC-80 Hz. Precision 16 bits.

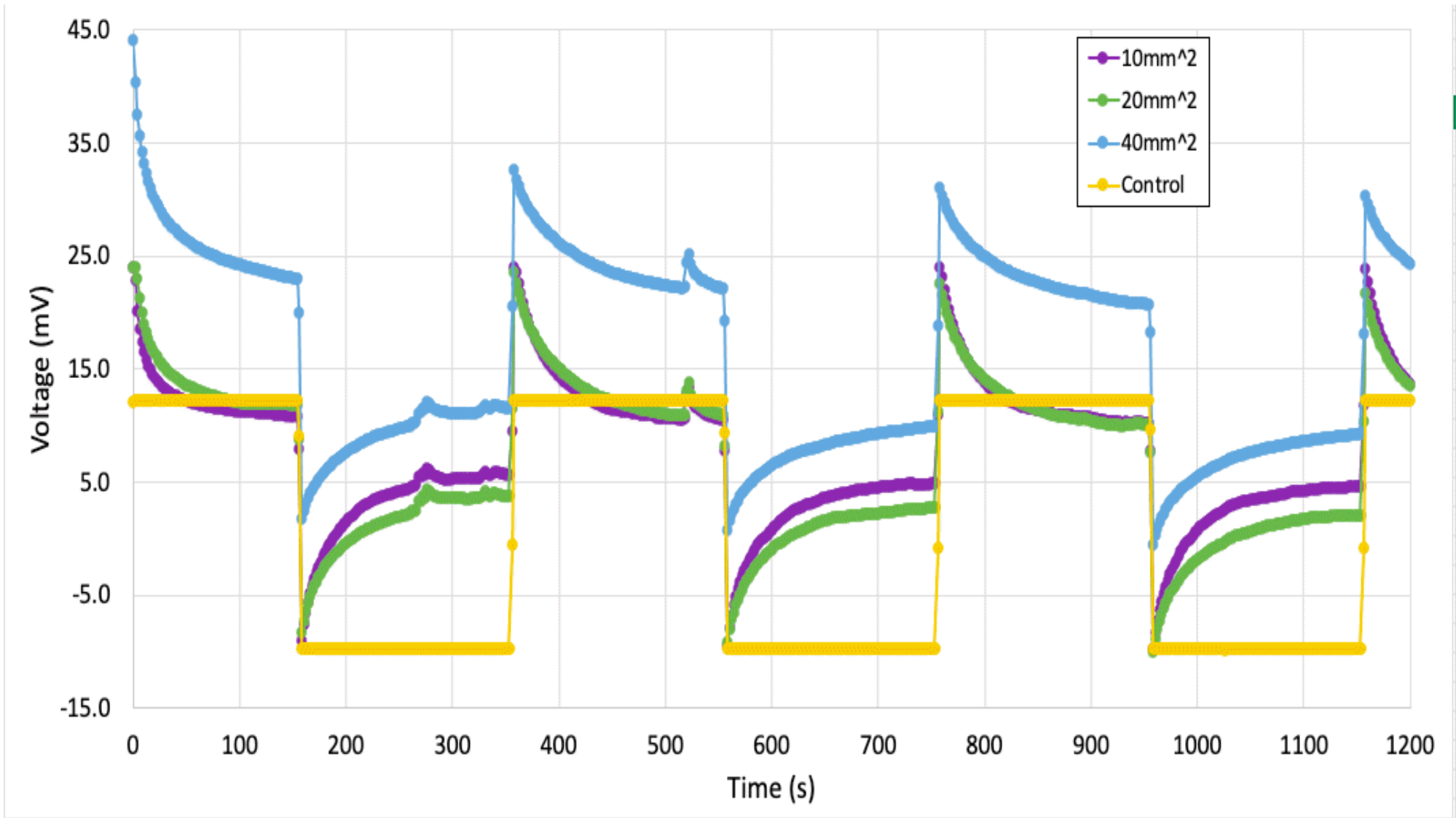


Methods: Schematic of Apparatus



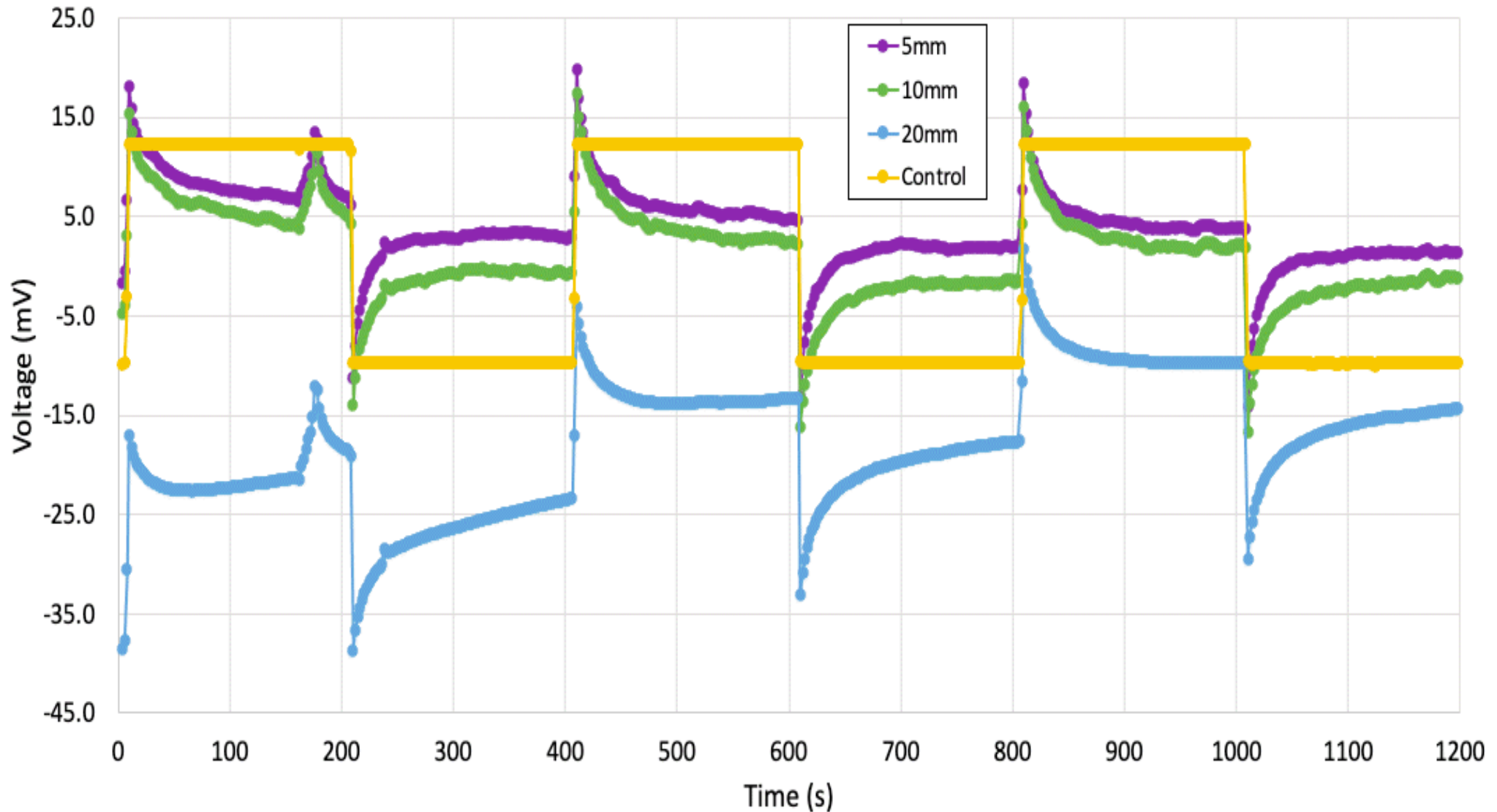
- One source electrode, one control electrode, three test electrodes.
- All electrodes made of the same metal.
- Source electrode much larger than pick-up electrodes.
- Test electrodes equidistant from source electrode.

Stainless Steel Sheet



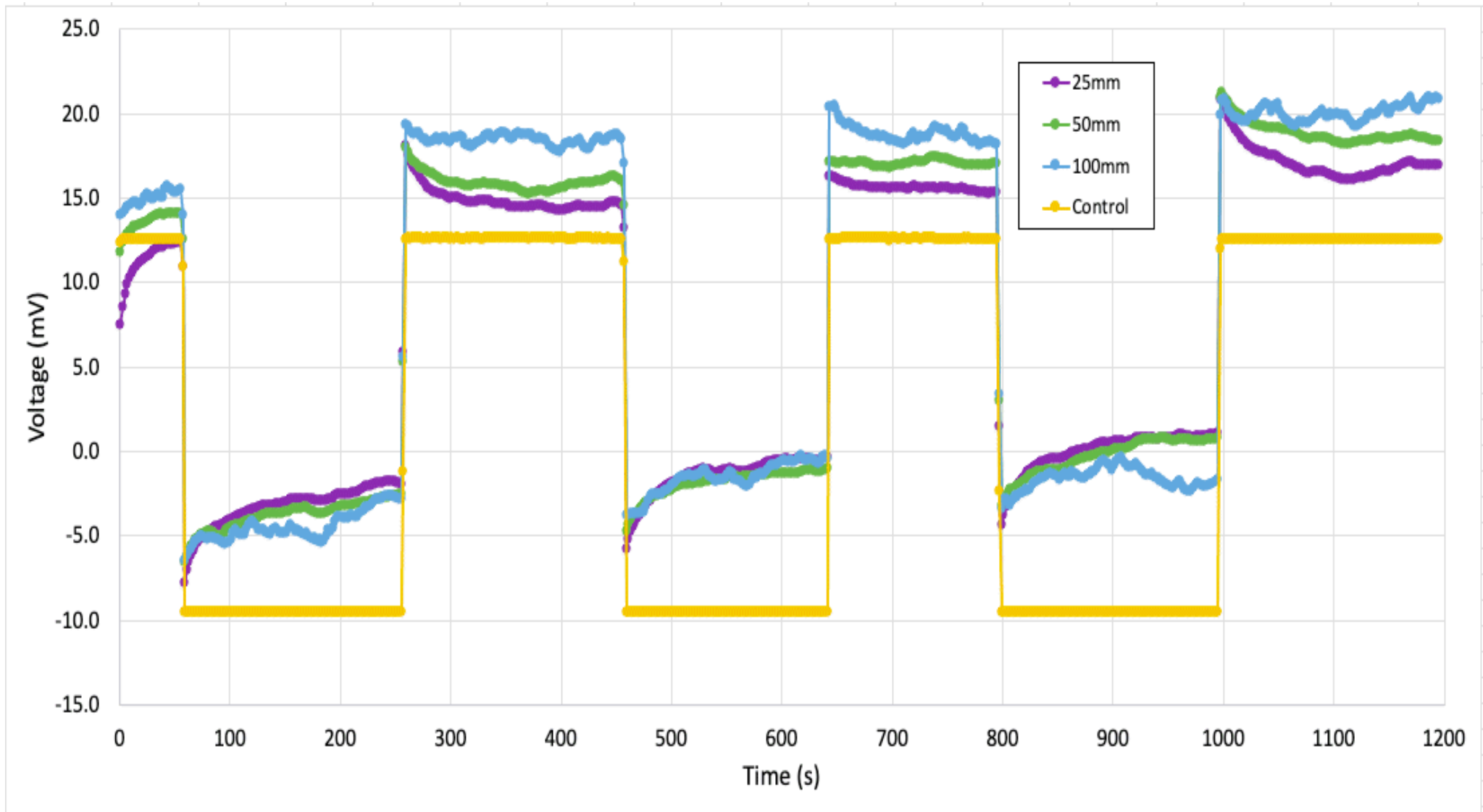
Yellow: Control. Purple, Green, Blue: 10, 20, 40 mm² 316SS.

Coiled Platinum-Iridium Wire



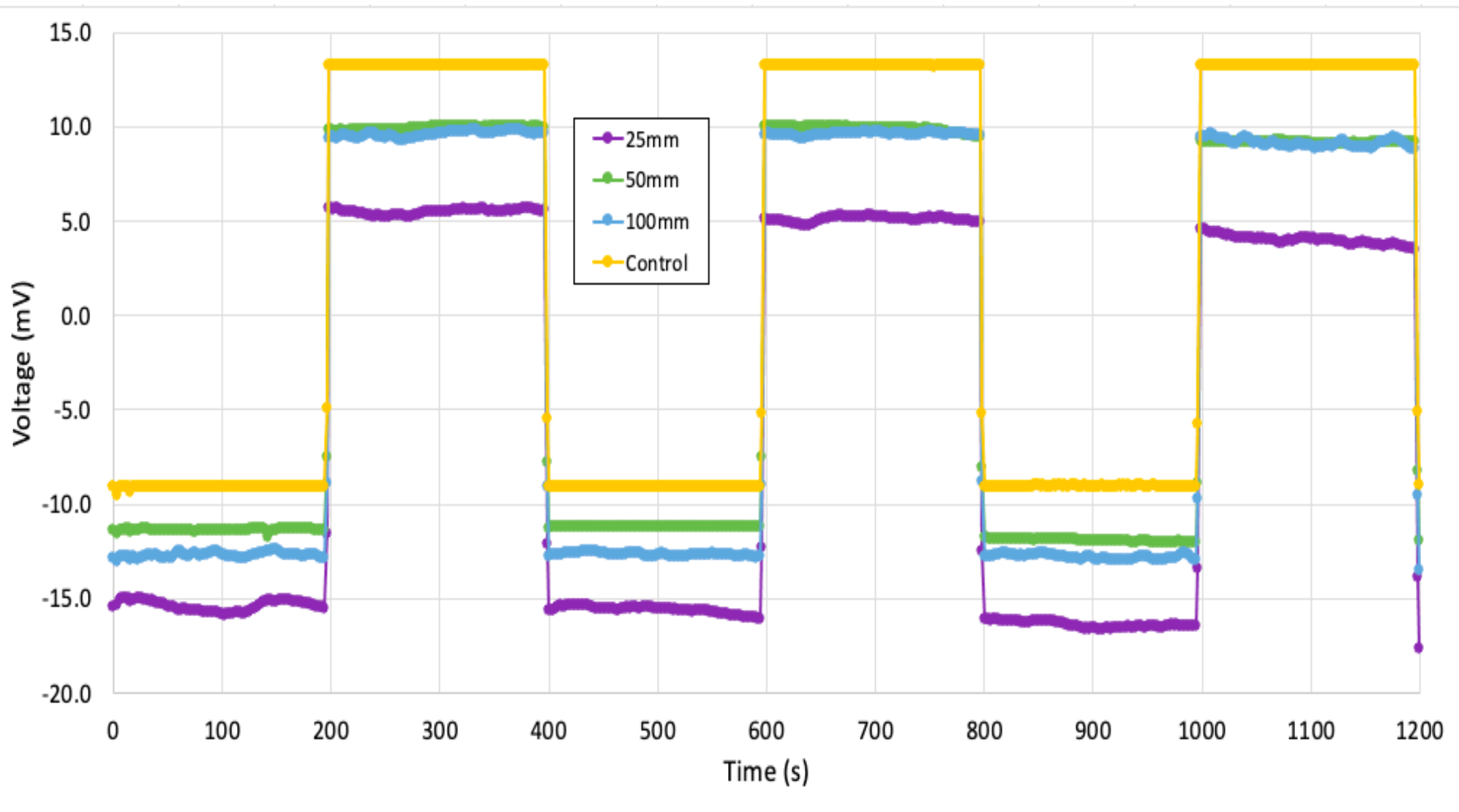
Yellow: Ctrl. Purple, Green, Blue: 5, 10, 20 mm of 125- μ m Ptlr.

Coiled Silver Wire



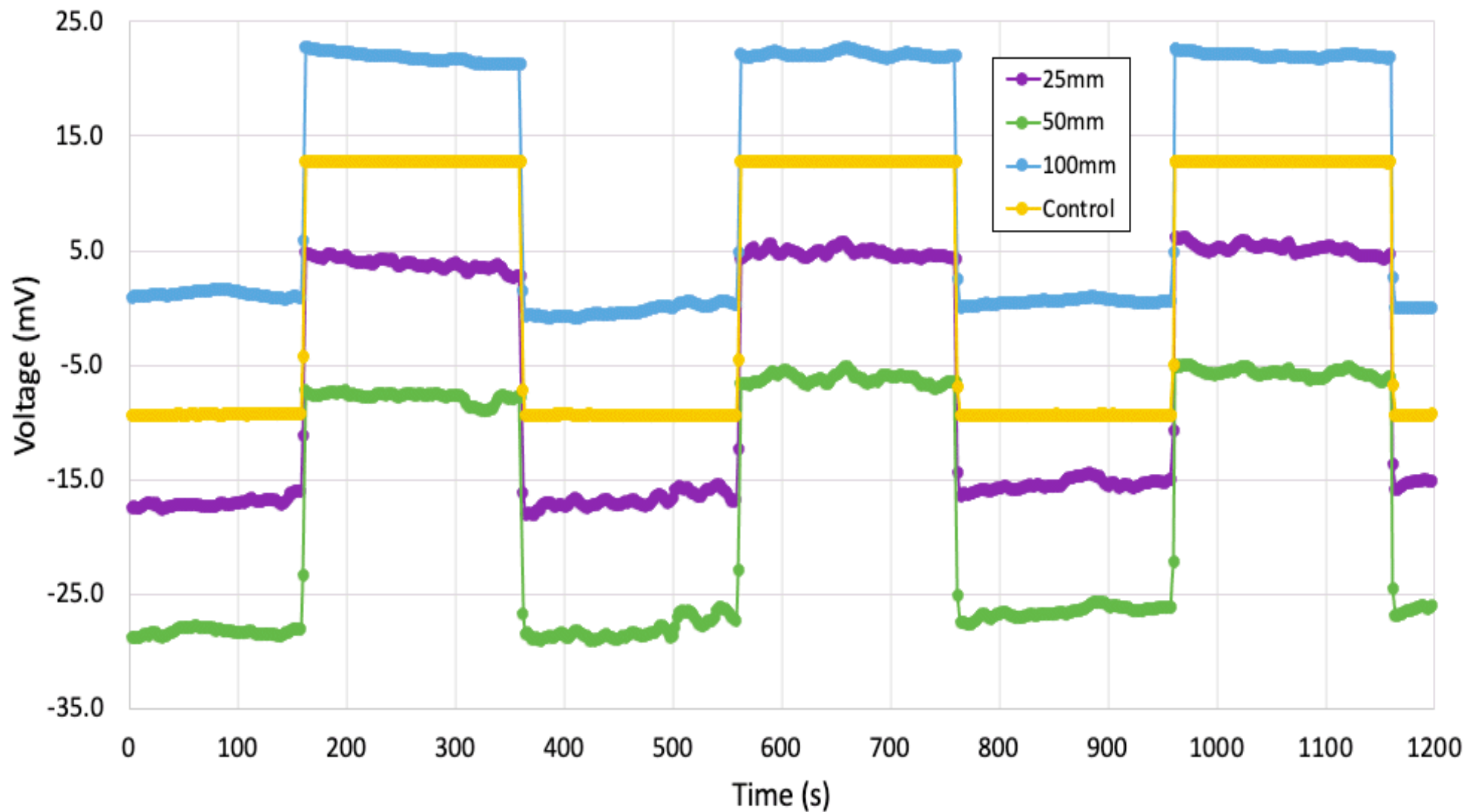
Yellow: Ctrl. Purple, Green, Blue: 25, 50, 100 mm of 125- μ m Ag.

Coiled Silver-Chloride Wire



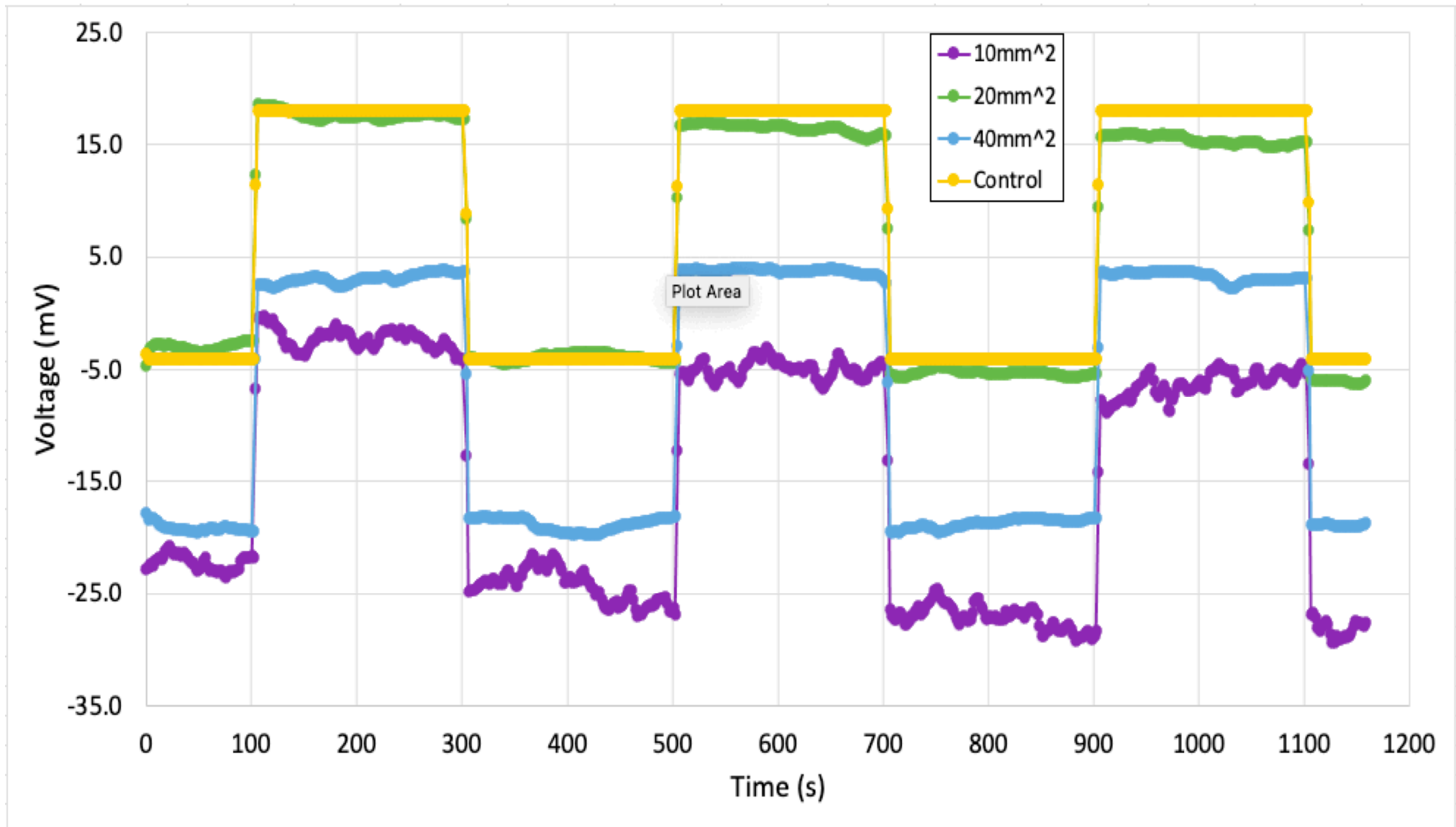
Orange: Cntrl. Purple, Green, Blue: 25, 50, 100 mm of 125- μ m AgCl.

Coiled Tungston Wire



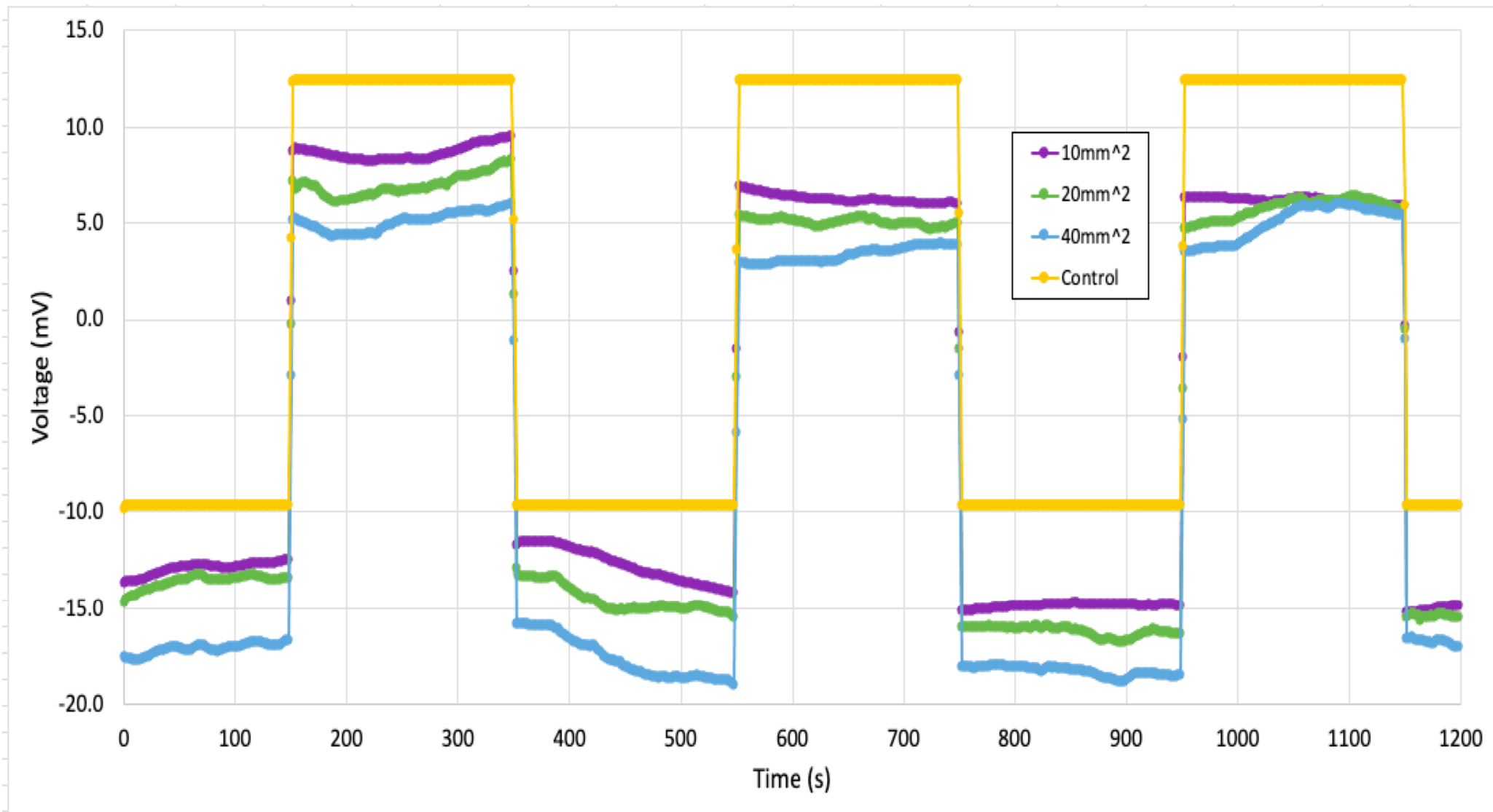
Orange: Cntrl. Purple, Green, Blue: 25, 50, 100 mm of 125- μ m W.

Copper Sheet



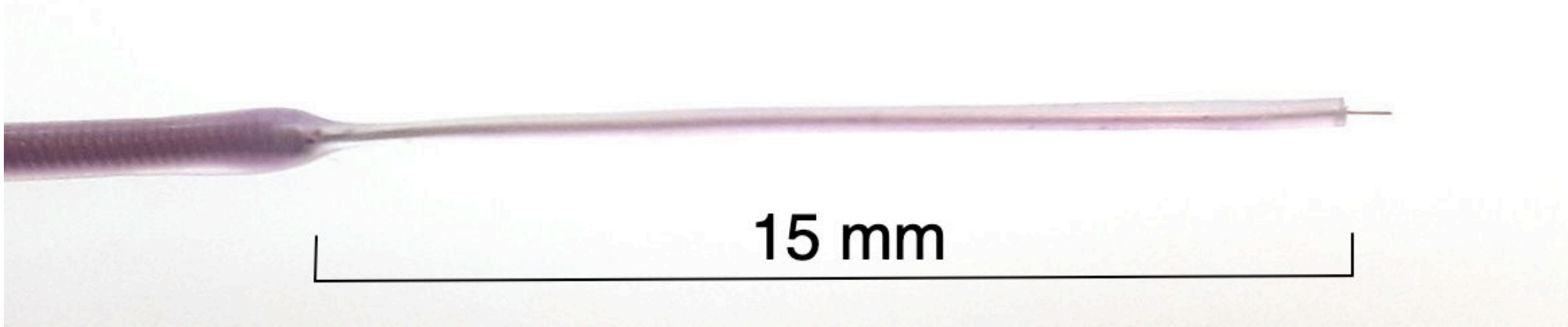
Orange: Cntrl. Purple, Green, Blue: 10, 20, 40 mm² of Cu.

Brass Sheet (70% Cu, 30% Zn)



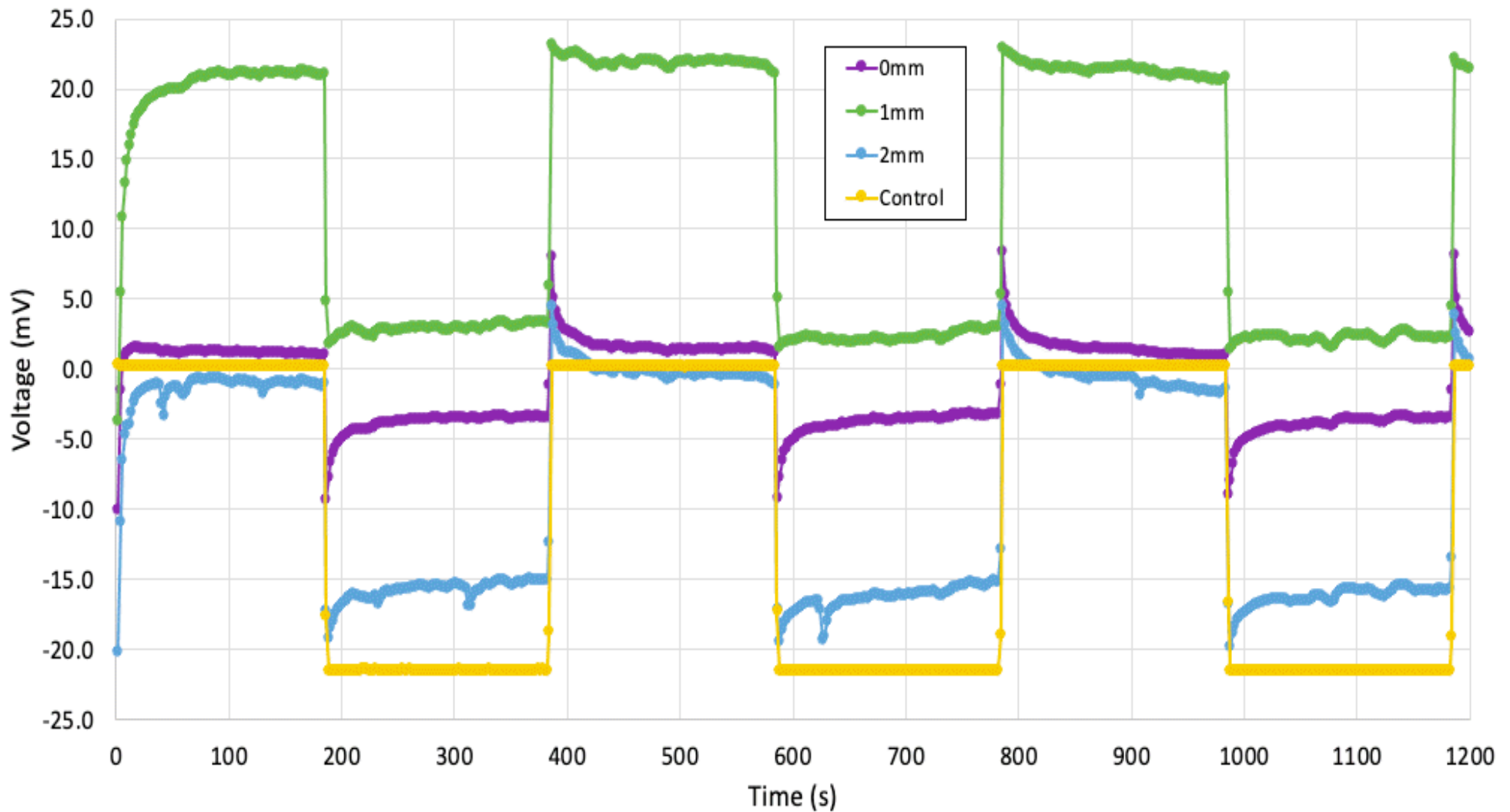
Orange: Cntrl. Purple, Green, Blue: 10, 20, 40 mm² of CuZn.

Silicone-Insulated Lead Termination



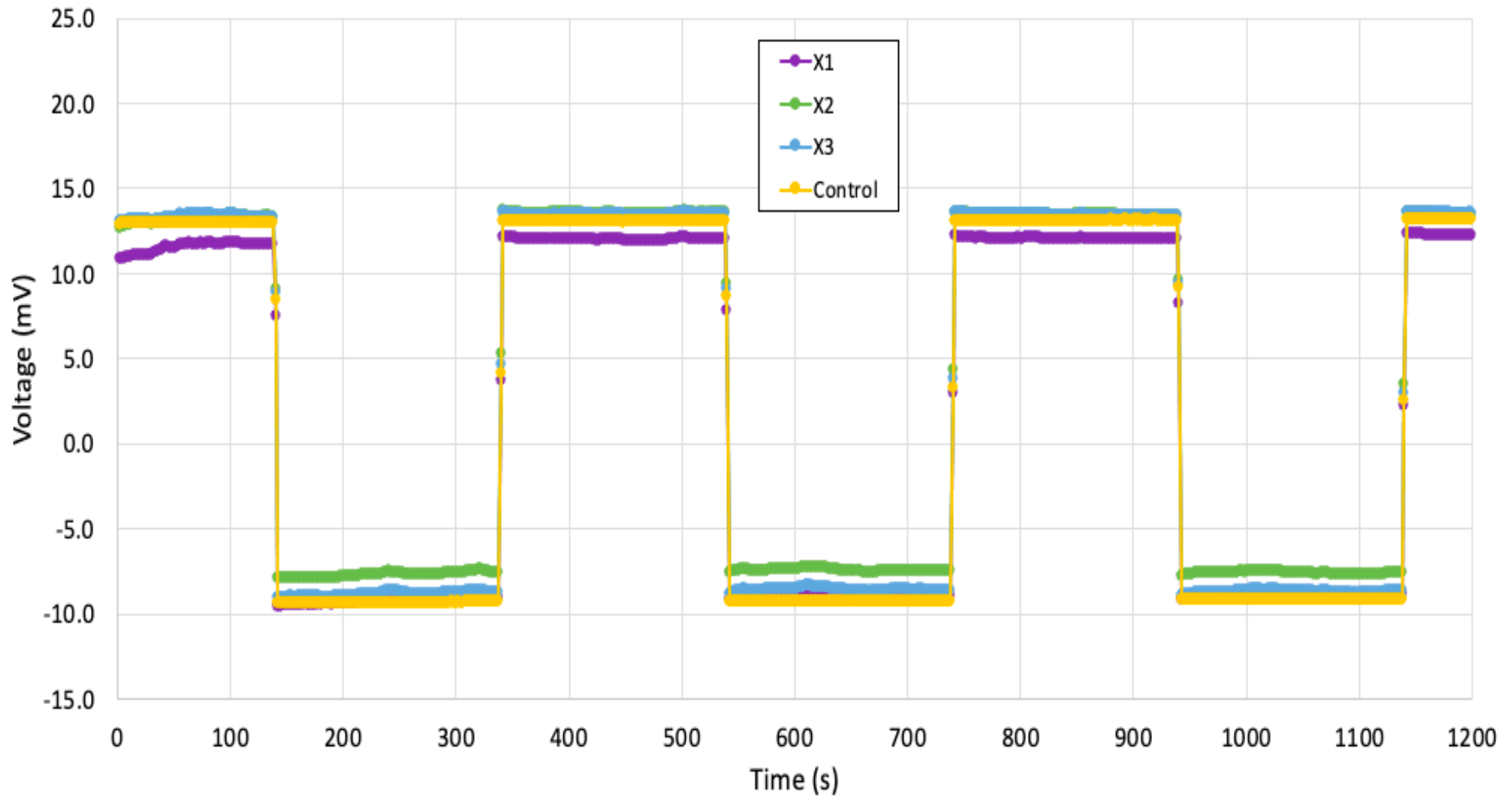
- Stainless steel spring soldered to silver wire.
- Insulated with silicone.
- Silicone can be dyed various colors.

Insulated Silver Wire



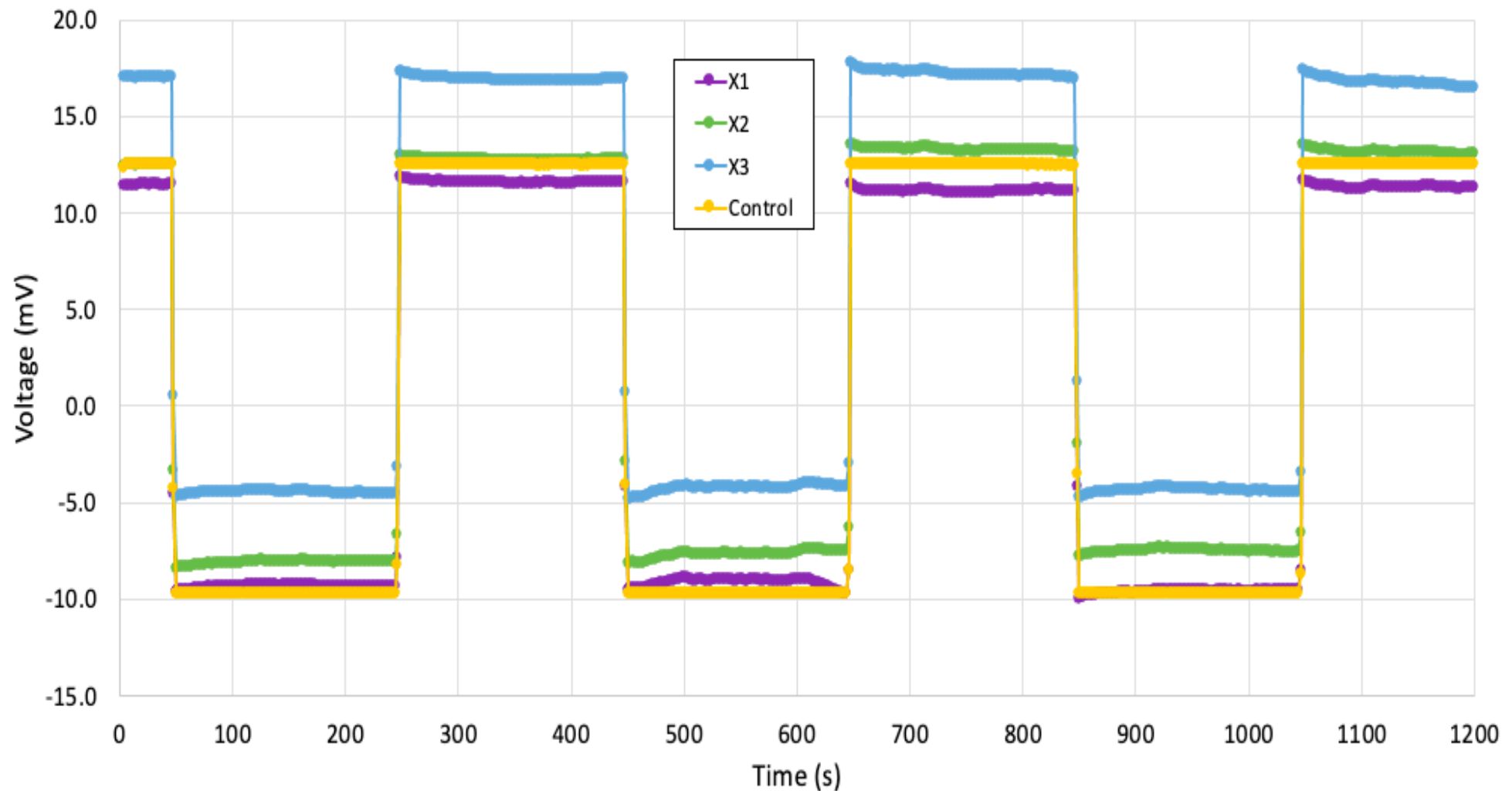
Orange: Cntrl. Purple, Green, Blue: 0, 1, 2 mm of 125-μm Ag.

Insulated Silver-Chloride Wire



Orange: Cntrl. Purple, Green, Blue: 1 mm of 125- μ m Ag-Cl.

Repeat Insulated Ag-Cl Wire



Orange: Cntrl. Purple, Green, Blue: 1 mm of 125- μ m Ag-Cl.

Conclusion

- Ag-Cl provides full amplitude, minimal offset and drift.
- Ag-Cl produces more artifact at > 0.5 Hz.
- Pt-Ir attenuates 2.5 mHz by 70%.
- Pt-Ir produces noise and drift.
- 316SS attenuates 2.5 mHz by 50%.
- 316SS is quiet and almost artifact-free.
- A 125- μm dia, 0-mm long Ag surface attenuates DC.
- For larger electrodes, area has little effect.