Point Electrical Stimulation Device for Engineered Tissues

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Abstract

The Scaffold Point Stimulation Device was developed to provide localized electrical stimulation to engineered cardiac tissues. Currently, only field stimulation devices exist and this Scaffold Point Stimulation Device provides a better replication of the SA node. The Scaffold Point Stimulation Device consists of a molded High Density Polyethylene (HDPE) dish, a stimulator and a point-stimulating electrode to send biphasic voltage through electroactive scaffolds. The voltage can be measured across the scaffold and the voltage distribution can be mapped with the use of a recording electrode and an oscilloscope. The final goal of the Scaffold Point Stimulation Device is to provide an electrophysiological environment that can enhance function of engineered cardiac tissues.

Customer Needs

- Biocompatible
- Low Cost
- Low Corrosion
- Simulates Cell Level Conduction
- Controllable Current
- Full Stimulation
- Scaffold is Held in Place
- Stimulation Pathway is Mapped
- No Electrode-Solution Contact

Design Concept

- A molded High Density Polyethylene (HDPE) bath houses the scaffold
- Two PFA-insulated tungsten electrodes have small tip exposure
- The scaffold is made of 15% polycaprolactone (PCL) and 0.5% Graphene
- The stimulating electrode sits in a capillary tube
- The tip of the stimulating electrode is welded to the scaffold with PCL
- The scaffold is 0.5 x 0.5 cm and is pinned to a polyethylene foam insulative pad inside the scaffold bath
- A micromanipulator moves the recording electrode with a 1 mm resolution
- The stimulator provides biphasic voltage [1]
- The recording electrode is connected to an oscilloscope
- The entire Scaffold Point Stimulation Device is illustrated in Figure 1

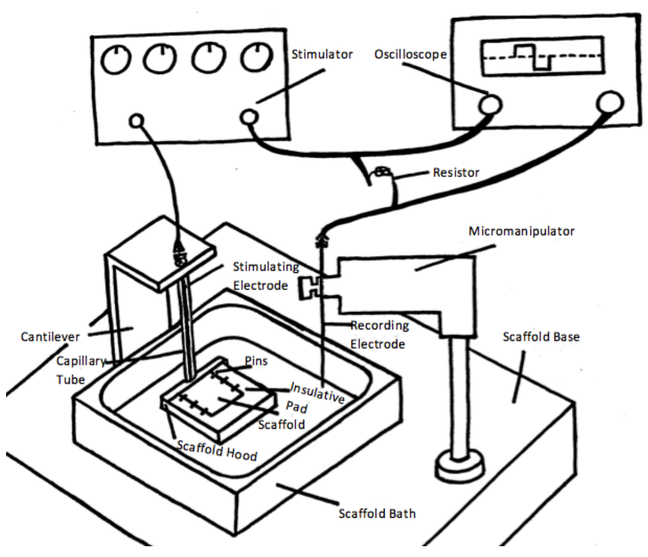

Figure 1. Setup of Device

- The circuit connections of the device are illustrated in Figure 2
- The Stimulator has an output of 10 V

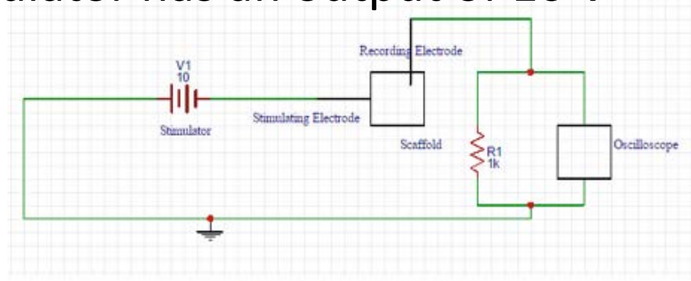

Figure 2. Circuit Connections

- The results of testing a cardiomyocyte-seeded scaffold are demonstrated in Figure 3 and Figure 4

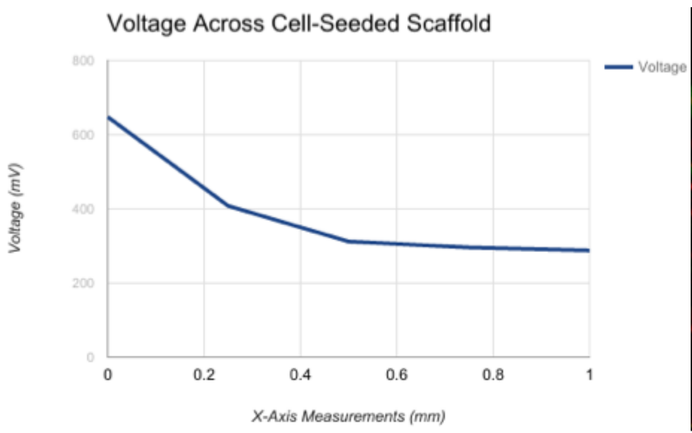

Figure 3. Results from Cell-Seeded Scaffold

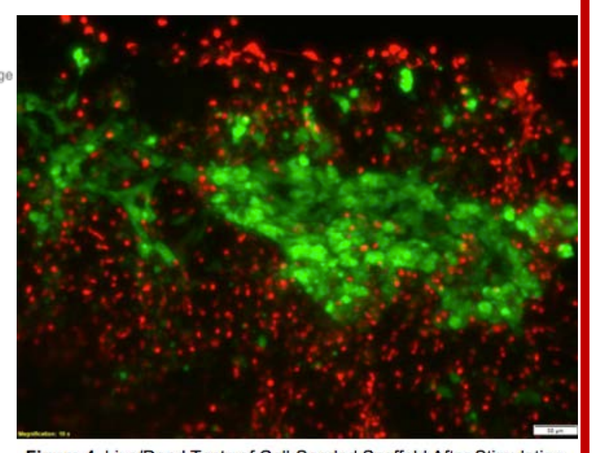

Figure 4. Live/Dead Tests of Cell-Seeded Scaffold After Stimulation

Test Plan

Test Case	Direct Requirement	Test
010	Scaffold Bath Design Cantilever Design Capillary Tube Design Scaffold Hood Design Electrode Design Electrode Material Insulative Pad Design	Physical Measurements
020	3D Printed Material Resistivity	Resistivity Measurements
030	Capillary Tube The Scaffold	Strength Measurements
040	Systems Connection	Electrical Connections
050	Systems Connection	System Testing

Acknowledgement

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References

[1] Barash, Y., et al. (2010). "Electric field stimulation integrated into perfusion bioreactor for cardiac tissue engineering." Tissue Eng Part C Methods **16**(6): 1417-1426.