3D Biophotonic Devices for All Optical Electrophysiology

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Optical actuation and sensing methods were demonstrated by GW for high-throughput drug and cardiotoxicity screening. However, modification of target cells takes time, has variable yield and can cause potential interference with cell’s innate functional responses.

GW researchers manufactured “spark-cell” spheroids, used as a reagent that can be frozen, transported, and deployed on-site to confer optical pacing of cardiac cells. Since the spheroids are genetically engineered, one no longer needs to genetically modify the target cardiomyocytes of interest. Such spheroids can respond to electrical, optical, magnetic, and ultrasound/mechanical actuation. The spheroids are designed for easy robotic application, can be guided to desired location, can be assembled in higher-order structures, and can provide optimal level of stimulation to the target cardiomyocytes.

**Applications:**

- High-throughput screening for cardiac toxicity
- Phenotyping iPSC-derived cardiomyocytes
- Tissue engineering and soft robotics

**Advantages:**

- Fast, cost-effective, high-throughput (>600 samples/hour)
- Allow precise optogenetic stimulation without genetic modification of cells of interest
- Allow all-optical electrophysiology - simultaneous voltage, calcium optical measurements
- Spheroids respond to electrical, optical, magnetic, and ultrasound signals
- Compatible with standard high-throughput plate format (96- or 384-well plates)
- Amenable to robotic handling for positioning and 3D tissue structure assembly

**Inventors**

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We experimentally integrate, test and validate new optical and optogenetic modalities for actuation
(stimulation) and sensing (optical mapping) of the electromechanical function in cardiac cells and tissues.

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