Docket #: S17-314

Conductive Graphene/Carbon Nanofiber Composite Scaffold for Neural Tissue Engineering

Stanford researchers have proposed the use of a conductive graphene scaffold (CGS) as a biocompatible scaffold for growth of neural tissues. The high conductivity enables the use of electrical stimulation to control the development of induced pluripotent stem cells (iPSCs). Neural regeneration using iPSCs offers the advantage of patient-specific derivation of neurons for neural recovery/regeneration. A 3D, cerebral cortex-like CGS exposed to electrical stimulation rapidly generates cortical neurons with more mature neuronal circuits. This provides an exciting platform to further investigate iPSC-derived neurons' integration and regulatory role in neurodegenerative and neurovascular disease.

Figure

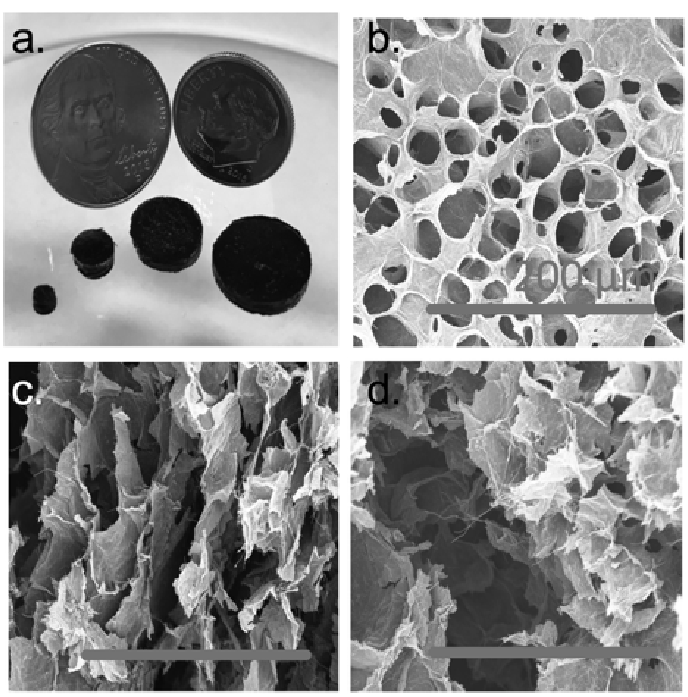

Figure description - (a) Different size of CGSs as compared to quarter (b) SEM image of CGS top surface (c) SEM image of CGS cross section area (d)SEM image of CGS cross section area with higher magnification

Stage of Research

The inventors have highlighted combined mechanical and electrical stimulation via a CGS to promote a 3D microniche for rapid, high-purity conversion and maturation of iPSC-derived neurons for regenerative and disease modeling applications. Although animal in vivo models have been developed to investigate the regulatory role of cortical neurons in various disease states including amyotrophic lateral sclerosis, spinal muscular atrophy, and addiction, such models do not necessarily represent human pathophysiology. By deriving iPSCs from patients with these disease states in our 3-D CGS system, tissue-like in vitro disease modeling and drug screening by directed differentiation of iPSCs with neuronal identity is possible. Such modeling is of paramount importance in exploring adequate therapeutic agents, as well as for a thorough understanding of cortical pathophysiology.

Applications

- Neurodegenerative and neurovascular disease modeling - Combined cues using soft CGS provides in vitro neurodegenerative disease modeling for exploring adequate therapeutic agents as well as for understanding brain pathophysiology
- **Neural tissue engineering** - CGS platform for culturing pluripotent stem cells in studies such as:
    - Investigating neural network regeneration mechanisms to identify therapeutic targets
    - Elucidating the role of electrical charge modulation on neural augmentation
    - Determining factors that are essential for neuronal regeneration and developmental stages
    - Delivering stem cells using brain tissue implants
- **Stem cell based therapy** for brain diseases including stroke, neurodegenerative disease, and glioblastoma
- Other potential applications include electrodes, supercapacitors, fuel cells, batteries, capacitive desalination devices, thermal and acoustic insulators, and chemical or mechanical sensors

Advantages

- **3D CGS** provides an advantage over traditional 2-D, inert polymeric, and organoid systems to allow for continuous interactions with in vitro stem cells. It also provides an avenue to rapidly mature neuronal cells from iPSCs derived from a particular patient for neural regenerative strategies.
- **Highly porous micro-niche and elastic modulus in the presence of CNF provides a soft scaffold for tissue engineering**
- **High electrical conductivity** uses electrical stimulation for controlling the differentiation and paracrine release of stem cells
- **Combined stimulation** determines factors that are essential for disease recovery
- **Overcomes the drawback of inert scaffold** in neural tissue engineering
- Optimizes stem cell-based stroke therapeutics
- Can modulate stem cells after transplantation
- Introduces a new method of stem cell delivery

Innovators

- Byeongtaek Oh
- Vivek Lam
- Paul George

Licensing Contact

David Mallin

Licensing Manager, Physical Sciences

Email