In-Incubator, Servo-Controlled Microvalve System for Automated Culture Management

Tech ID: 34066 / UC Case 2025-929-0

BACKGROUND

Advances in biological research have been greatly influenced by the development of organoids, a specialized form of 3D cell culture. Created from pluripotent stem cells, organoids are effective in vitro models in replicating the structure and progression of organ development, providing an exceptional tool for studying the complexities of biology. Among these, cerebral cortex organoids (hereafter "organoid") have become particularly instrumental in providing valuable insights into brain formation, function, and pathology. Despite their potential, organoid experiments present several challenges. Organoids require a rigorous, months-long developmental process, demanding substantial resources and meticulous care to yield valuable data on aspects of biology such as neural unit electrophysiology, cytoarchitecture, and transcriptional regulation. Traditionally the data has been difficult to collect on a more frequent and consistent basis, which limits the breadth and depth of modern organoid biology. Generating and measuring organoids depend on media manipulations, imaging, and electrophysiological measurements. Historically are labor- and skill-intensive processes which can increase risks associated with experimental validity, reliability, efficiency, and scalability.

TECHNOLOGY DESCRIPTION

To help address these challenges in 3D culture automation, a research team at UC Santa Cruz (UCSC) has developed a newer approach to automating the handling media and reagents, towards significant improvement in maintaining long term cell cultures. UCSC's in-incubator, closed-loop subsystem operates with a 24-well plate using a custom microvalve system under servo control. Each of the 24 wells is isolated and addressable via square microchannels with dedicated inlets, outlets, and collection reservoir. Featuring special valve seat geometries and coupling mechanisms, the custom microvalve subsystem has exceeded expectations with >12,000 cycles to date without servo failures. Moreover, the subsystem was designed to permit unobstructed viewing from above, allowing real-time imaging/lighting of wells from the top-view. And while the system was designed to integrate seamlessly with smaller footprints, its modular architecture is easily changeable and scalable.

APPLICATIONS

- diagnostics – neuro
- therapeutics – neuro
- research tools – neuro

FEATURES/BENEFITS

- Avoids bulk and complexity of traditional pneumatic valve systems, including additional control channels, pressure/vacuum inlet ports, external tubing, solenoid valves, and pressure/vacuum sources.
- Permits unobstructed imaging and enables automated control of flow across entire plate.
- Features special valve seat geometries and coupling mechanisms for superior seal reliability.
- Compact and flexible design for smaller footprints e.g. common cell culture incubators.

INTELLECTUAL PROPERTY INFORMATION

Patent Pending

RELATED MATERIALS

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OTHER INFORMATION

KEYWORDS

organoid, cortex organoid, brain organoid, electrophysiology, neural, neuron, neuronal, cell culture, 3-D cell culture, 3D cell culture, hands free cell culture, neuro, neuroscience, neurotechnology

CATEGORIZED AS

- **Computer**
  - Software
- **Medical**
  - Disease: Central Nervous System
  - Research Tools
  - Screening
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