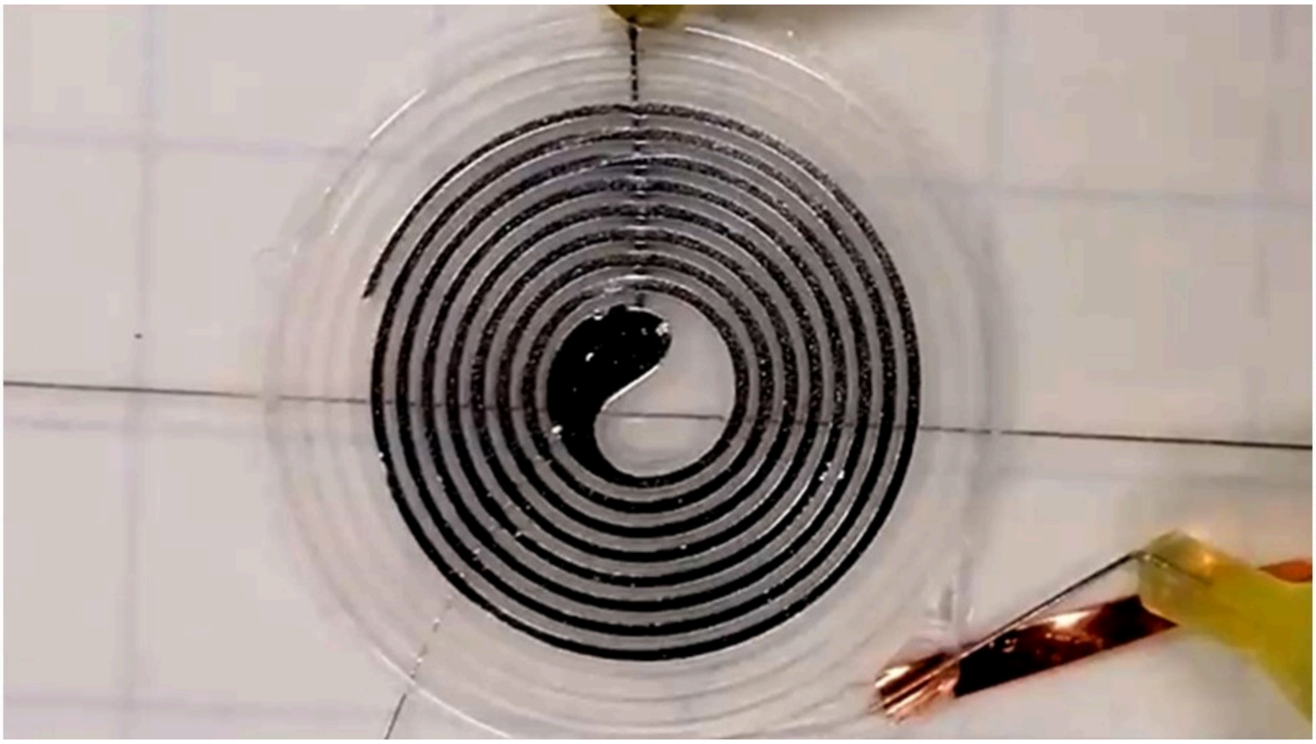
TECH OFFER

# Thin Film-Based Microfluidic Electronic Device



## KEY INFORMATION

TECHNOLOGY CATEGORY:
**Electronics** - Printed Electronics
**Manufacturing** - Additive Manufacturing
**Materials** - Plastics & Elastomers

TECHNOLOGY READINESS LEVEL (TRL): TRL4
COUNTRY: SINGAPORE
ID NUMBER: TO174500

## OVERVIEW

Gallium-based room temperature liquid metal alloys have been widely adopted for flexible and stretchable electronics due to their high conductivity, negligible vapour pressure, low viscosity, and low toxicity. Several techniques have emerged for patterning liquid metals. However, the estimated resistivity of gallium oxide is 10-fold higher than the bulk liquid metal and thus the oxide skin causes an increase in contact resistance between liquid metals and other electrical components in electric circuits. To recover the conductivity, the oxide skin needs to be ruptured by laser and thermal sintering.

To avoid the generation of the oxide skin, the liquid metals are commonly injected into the microchannels to fabricate stretchable electronic devices using prefabricated microchannels. The presence of microchannels, however, may compromise the overall flexibility of the device.

Overall, existing techniques for fabricating microfluidic electronic devices have various deficiencies such as in relation to:

(1) laborious manual processes that require the use of a clean-room facility and vacuum systems,

(2) limitation in choice of materials used as the substrate of microchannels,

(3) limitation in the thickness, flexibility and stretchability of the microfluidic device.

This technology offer is the first reported use of direct ink writing (DIW) 3D-printing technology for the fabrication of liquid metal-injected silicone-based stretchable microchannels on flexible and stretchable thin-film substrates including commercially available skin-adhesive plaster and silicone elastomer (Ecoflex) ultrathin films.

The technology owner is looking for licensees to commercialise this technology.

## TECHNOLOGY FEATURES & SPECIFICATIONS

Free-standing and fully-stretchable liquid metal-injected microchannels laden thin-film devices can be obtained with the water-soluble sacrificial layer methods to facilitate the injection of the liquid metal. These devices using DIW 3D printed microchannels on the thin-film (less than 25 µm thick) substrate provide higher adhesiveness to the human skin surface than conventional microfluidic devices based on liquid metal microchannels embedded in the substrate with a homogeneous thickness (hundreds of µm).

With the use of DIW, silicon elastomers which is a readily available and economical material can be printed directly on the thin film in multiple layers to create fully covered thin channels for the injection of the liquid metal. This allows the flexibility of printed channel designs, including multilayer designs as long as there is a connected path for the liquid metal to flow through. This makes it convenient for the microchannels to be designed to accommodate external components as well or to fit into tight spaces. Thin channels which are constraint by the size of the DIW nozzle and pressure can be made which helps in keeping the microchannel small.

## POTENTIAL APPLICATIONS

This technology can be used for flexible and wearable biosensors, soft robotics, implantable medical devices, human-machine interfaces, and clinical diagnosis.

It can also be used for in vivo collection of diagnostic and medical data due to its ability to manoeuvred into miniaturized forms that can be passed through the body.

## MARKET TRENDS & OPPORTUNITIES

The printed electronics market is expected to grow with a CAGR of 7% from $12.62 billion in 2021 to 2028. Its major growth drivers are increasing application of printable electronics in the internet of things and significant cost advantage. Its prospect looks promising in the automotive & transportation, healthcare, consumer electronics, aerospace, defense, construction, architecture, retail and packaging industries.

## UNIQUE VALUE PROPOSITION

- Due to the flexibility and stretchability of the silicon elastomer itself and the fluidity of the liquid metal to flow and adapt to any shape, the microchannel is flexible and can be bended, stretched and rolled while remaining conducting and electrically functional.

- Electrical components such as IC chips and LEDs can be embedded in the outline of the microchannel and electrically connected by injection of the liquid metal into the microchannel. This electrical connection is a useful alternative method to mount electrical components in the circuit for the fabrication of flexible electronics.
- Moreover, silicon elastomer's hydrophobic nature allows the microfluidic device to remain functional in conditions that requires waterproofing, e.g sweat, blood or water, hence allowing it to remain functional over a large range of conditions and robust majority of daily human activity.

The technology owner is keen to out-license this technology to direct end application developers such as medical device manufacturers, or conductive ink manufacturers and flexible substrate manufacturers.