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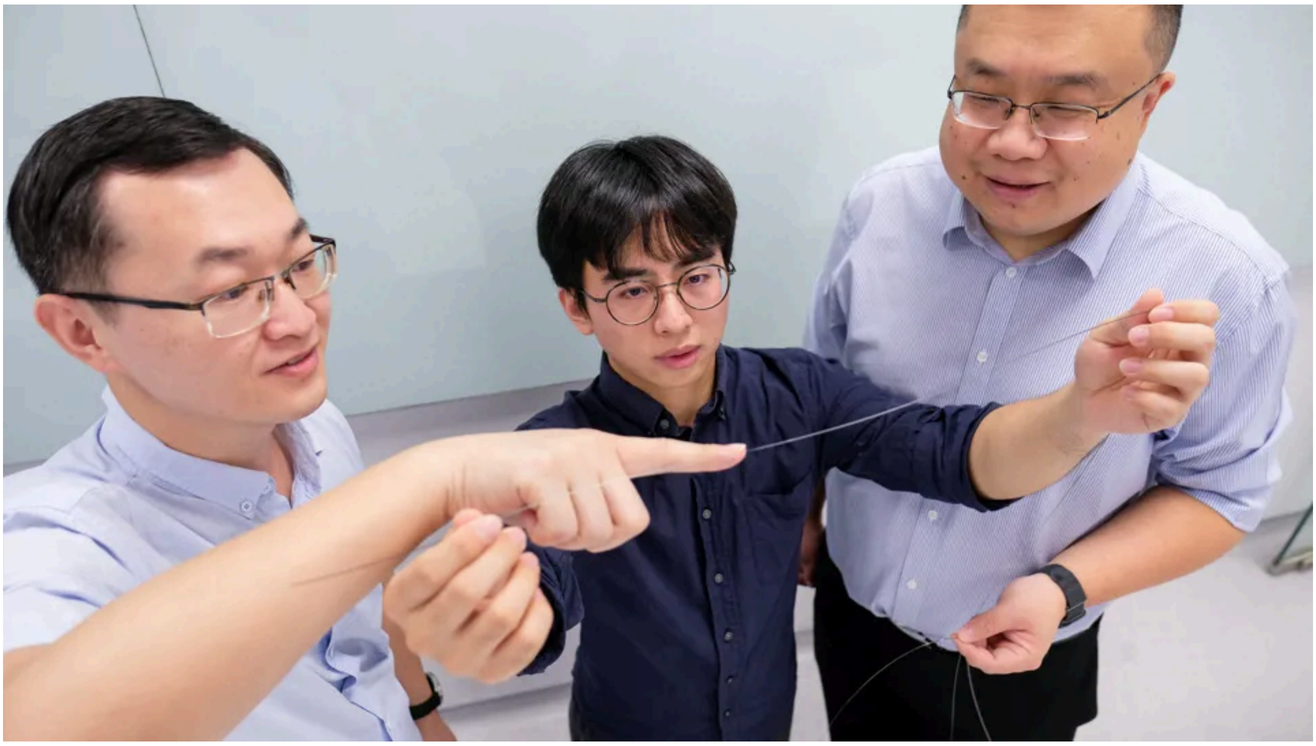
Wearable Technology Materials Electronics

# NTU Singapore develops ultra-thin semiconductor fibres for wearable electronics

News

**Nanyang Technological University, Singapore (NTU Singapore) has developed ultra-thin semiconductor fibres that can be woven into fabric and turned into smart wearable electronics.**



Members of the NTU research team include Dr Li Dong, Research Fellow; Dr Wang Zhixun, Research Fellow; and Assoc Prof Wei Lei (left to right) at the School of Electrical and Electronic Engineering - *NTU Singapore*

According to the researchers, to create reliably functioning semiconductor fibres, they must be flexible and without defects for stable signal transmission, but that existing manufacturing methods cause stress and instability leading to cracks and deformities in the semiconductor cores.

NTU Singapore conducted modelling and simulations to understand how stress and instability occur during the manufacturing process and found that the challenge could be overcome through material selection and a series of steps taken during fibre production.

Researchers successfully fabricated hair-thin, defect-free fibres that can span 100m and can be woven into fabrics using existing methods to develop wearable electronic prototypes.

In a statement, NTU Associate Professor and lead principal-investigator, Wei Lei, said: “The successful fabrication of our high-quality semiconductor fibres is thanks to the interdisciplinary nature of our team. Semiconductor fibre fabrication is a highly complex process, requiring know-how from materials science, mechanical, and electrical engineering experts at different stages of the study.

“The collaborative team effort allowed us a clear understanding of the mechanisms involved, which ultimately helped us unlock the door to defect-free threads, overcoming a long-standing challenge in fibre technology.”

#NTUsg scientists create hair-thin semiconductor fibres that can be wove...

The NTU-led team selected pairs of common semiconductor material and synthetic material - a silicon semiconductor core with a silica glass tube and a germanium core with an aluminosilicate glass tube.

The materials were selected based on their attributes which complemented each other, including thermal stability and electrical conductivity.

Silicon was selected for its ability to be heated to high temperatures and manipulated without degrading. It also works in the visible light range, making it ideal for use in devices meant for extreme conditions, such as sensors on the protective clothing for fire fighters.

Germanium allows electrons to move through the fibre quickly and work in the infrared range, which makes it suitable for applications in wearable or fabric-based sensors that are compatible with indoor Light fidelity ('LiFi') wireless optical networks.

Researchers inserted the semiconductor material (core) inside the glass tube, heating it at high temperature until the tube and core were soft enough to be pulled into a thin continuous strand.

"By exploiting the different melting points and thermal expansion rates of our chosen materials, we successfully pulled the semiconductor materials into long threads as they entered and exited the heating furnace while avoiding defects," said first author of the study Dr Wang Zhixun, NTU Singapore.

The glass is removed once the strand cools and combined with a polymer tube and metal wires. After another round of heating, the materials are pulled to form a hair-thin, flexible thread.

When subjected to responsivity tests, the fibres could detect the entire visible light range, from ultraviolet to infrared, and transmit signals of up to 350kHz bandwidth. The fibres were 30 times tougher than regular ones and multiple machine washes did not impede performance.

The researchers developed multiple prototypes to test the fibres, including a smart beanie hat to help a visually impaired person cross the road safely through alerts on a mobile phone application; a shirt that receives information and transmits it through an earpiece, like a museum audio guide; and a smartwatch strap that functions as a flexible sensor that measures heart rate during physical activities.

Looking ahead, the researchers said they are aiming to expand the types of materials used for the fibres, and develop semiconductors with different hollow cores, such as rectangular and triangular shapes, to expand their applications.

The research paper, published in *Nature*, can be read in full here.