The Future Possible Diabetes Management Method–Scientists Use Silk of Nephila pilipes to Develop a Fiber Optic Sugar Sensor for Glucose Measurement

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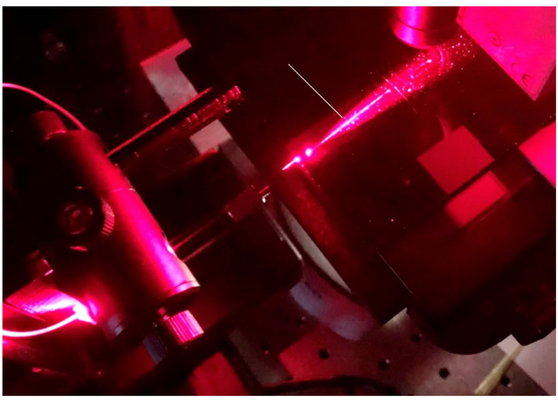


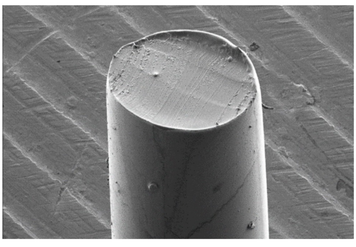
Spiders are often pictured as villains in literary works or films, and *Nephila pilipes*, which is the size of a palm, is particularly dreadful to many. Despite this, spiders probably will not be considered so negative if its silk can be used to measure glucose as a tool for managing diabetes someday.

Professor Liu Cheng-yang and E Hsuan-pei, a master's graduate, from the Department of Biomedical Engineering at National Yang Ming Chiao Tung University (hereafter NYCU) used the silk of *N. pilipes* to develop a fiber optic sugar sensor capable of measuring fructose, sucrose, and glucose within 0.1 ms. Because its measuring range covers all possible glucose levels inside a human body, the sensor is suitable as a next-generation glucose meter.

As population ages, diabetes has become a common disease. Measuring glucose at home with lancets puts patients at a risk of infection; furthermore, all used lancets are considered medical waste. Therefore, scientists have been working to develop more convenient ways to measure glucose in real time.

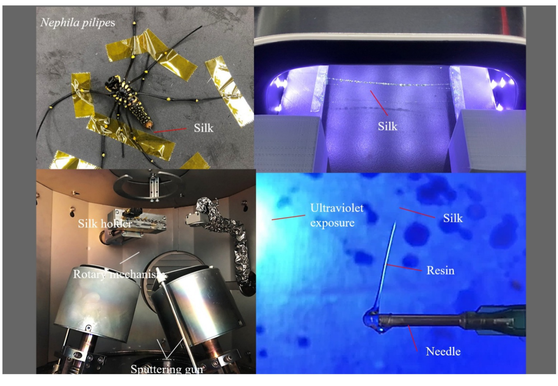
Different from the traditional glass or plastic fiber optics, spider silk exhibits a high tensile strength, transmits light waves, and, for its high biocompatibility, is suitable for the human body. The research and development team led by professor Liu collaborated with Taipei Medical University and the Taiwan Instrument Research Institute of National Applied Research Institute to obtain natural spider silk from living spiders. Photocurable resin was used to stabilize the structure of the spider silk before a thin gold nanolayer was deposited on the surface of cured silk by using glancing-angle sputtering to enhance the spider silk fiber optic's sensitivity to sugar. Finally, a visible fiber optic sensor with a diameter similar to that of human hair was fabricated.

Based on the optical physical principles of surface plasmon resonance, scientists can calculate the refractive index of different types of sugar on metals, thereby determining changes in the sugar concentration. This fiber optic sensor developed by Liu has been verified through experiments to maintain its sensitivity at the same level within one year and to function normally at room temperature and human body temperature.



In fact, the research and development team have tried using two or three spider breeds and also spiders they found on the campus in their experiments in order to obtain suitable materials. However, silks from these spiders all exhibit substandard quality. They had experimented with different spider silks before they settled on *N. pilipes* as the source of silk. To ensure the quality of spider silk, the team also learned to keep spiders and designed an appropriate silk collection method.

Ms. E said that she was afraid of *N. pilipes* because of its large size and the human face–like pattern on its back and that the silk collection process was frightening to the team because the spider was not easy to keep under control and was always running around during the process. For the making of spider silk fiber optics, the team experimented with various types of resins and metals, including gold, silver, and copper. The team also had a chance to meet owners of a reptile shop and resin businesses during the process, which was an unexpected reward to them.



Liu indicated that patients with diabetes need to measure their glucose before and after every meal; therefore, a glucose sensor that is suitable for long-term use in the human body and offers real-time, accurate glucose measurement can obviate the hustle the patients face and achieve the goal of precision medicine; consequently, this sensor can benefit an even wider population of patients with chronic diseases.

This achievement is owed to the joint effort of NYCU, researchers Chen Wei-chun and Chen Che-chin at the Taiwan Instrument Research Institute of National Applied Research Institute, and professor Cheng Chia-hsiung at Taipei Medical University. The research outcome will be published in the September issue of *Biomedical Optics Express* this year as the editor's pick.