New graphene sensor to improve hepatitis diagnosis

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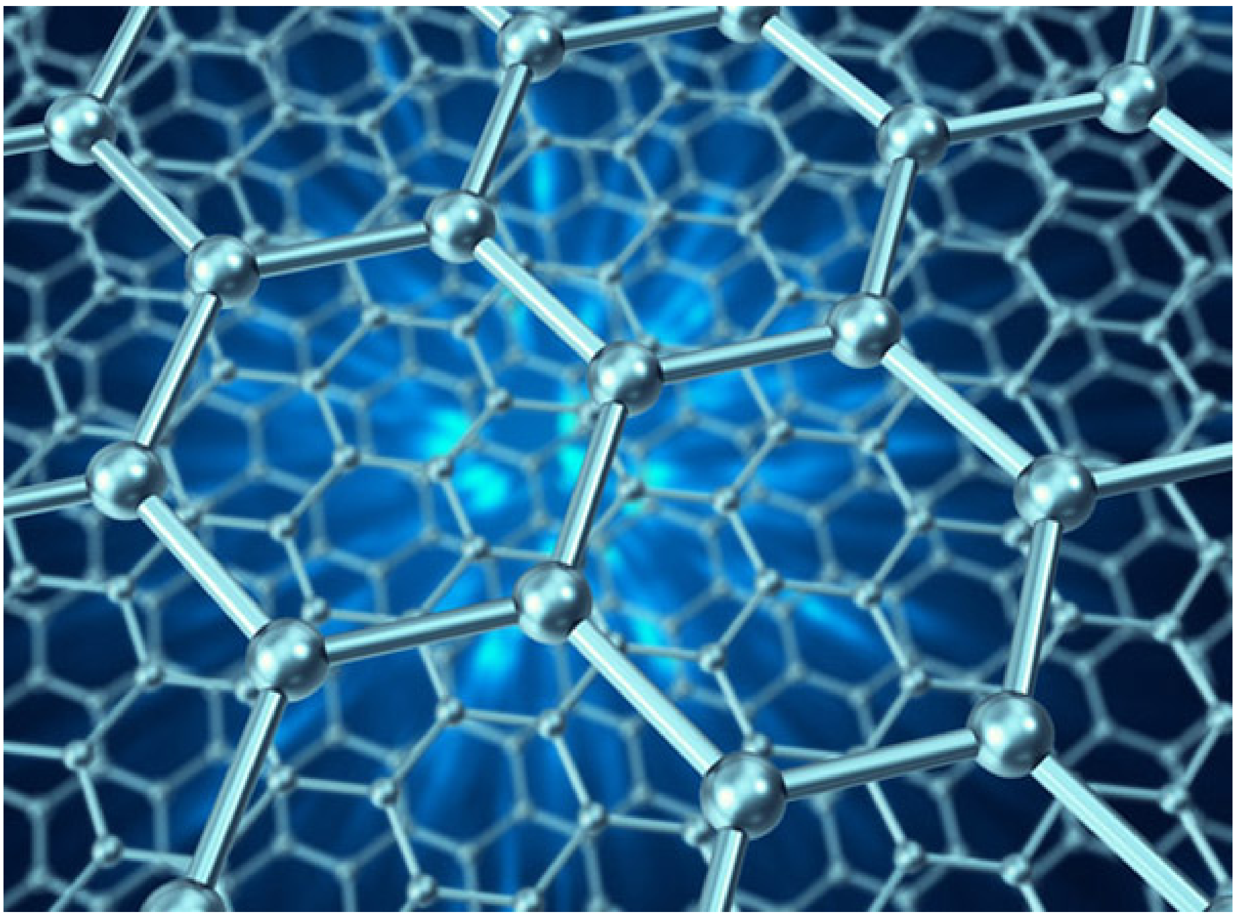

Credit: National Physical Laboratory

A new UK-China collaborative project is developing a sensor to provide an easy, low-cost method of diagnosing hepatitis on the spot using graphene – an advanced 2-D material known for its high electrical conductivity. The sensor will be the first to simultaneously test for three types of hepatitis – A, B and C – out of the five types that exist. The multi-partner project, supported by the UK's Newton Fund and led by Biovici, will bring together the National Physical Laboratory (NPL), the University of Chongqing, Swansea University, and industry partner CTN, to develop this new diagnostic technology.

Hepatitis is a huge global health problem, with nearly 400 million people worldwide affected, resulting in over 1.4 million deaths per year. The World Health Organisation has reported that 257 million people are infected with hepatitis B alone. Those affected with hepatitis suffer chronic infection, resulting in one million deaths per annum from liver cirrhosis and cancer, with 40% of those deaths occurring in China. Funded by the UK's Newton Fund, which aims to promote the economic development and social welfare of partner countries by strengthening science and innovation capacity, this project aims to help tackle the incidence of hepatitis in China. Hepatitis B in particular is endemic in China, with one-third of the 350 million infected individuals worldwide residing in China.

Blood tests are currently used as the diagnostic method for hepatitis, but there are challenges associated with this. With blood tests, results can take five to seven days, during which patients are still contagious and therefore a risk to the non-infected. Moreover, the technique is invasive and expensive, as it requires medical personnel.

Graphene is a 2-D material with unique electrical and mechanical properties, which derive from its one-atom-thick structure. The material's exceptional electronic characteristics, surface sensitivity and selectivity make it ideal for sensor applications, including those used for medical diagnosis. To date, graphene electrochemical biosensors exist for diagnosing one type of hepatitis. This project, however, will develop sensors for the detection of three hepatitis types at a time, by using three graphene sensors, each tailored to identify the antibodies associated with a certain strain of hepatitis, integrated in a single test. Unlike conventional blood tests, this sensor will provide a non-invasive, quick and less expensive screening method. The ease and speed of this method will be beneficial for bulk testing of the food, agriculture and education workforces in China, over 300 million people, for whom tests are obligatory.

The team's approach is to use the graphene sensor technology to develop a point of care diagnostic for early detection and monitoring of multiple salivary or serum-based hepatitis biomarkers. This will be a novel, real-time monitoring sensor technology, based on chemically-modified graphene, that simultaneously monitors for hepatitis A, B and C. The test will be simple, low-cost and rapid, similar to a blood glucose sensor or pregnancy test, but testing saliva instead. This two-year project will develop a prototype, and establish the reliability, stability and sensitivity of the sensor in preparation for its commercialisation. It is estimated that if the sensor is produced in large quantities, each device could cost as little as £1 GBP.

While each of the five partners involved in the project has a different role, all of their activities are required in combination for the effective development of this new technology. The two Chinese partners, CTN and Chongqing University, are responsible for graphene device production and manufacturing. On the characterisation side, NPL is carrying out electrical characterisation and testing, whilst Swansea University is conducting chemical characterisation. Lastly, Biovici, who develops next-generation POC diagnostic devices, is responsible for packaging and commercialisation.

Dr Olga Kazakova, Principle Research Scientist in Advanced Materials at NPL, said: "Graphene's unique characteristics mean it has great potential to be used in a variety of sensing applications. In addition to hepatitis, it could be used in other similar tests, including allergen sensors, pollutant identification and other life sciences applications. It is imperative for us to understand the exact characteristics of the material to be able to assess how it can be manufactured and used in these different applications. This is a key focus for us and the National Graphene Metrology Centre at NPL supports the commercialisation and application of the advanced material by conducting world-leading research into its measurement and characterisation. Through this research, we are working to develop international standards for graphene which will help to unlock new applications for the incredible material."

Paul Morgan, Chief Executive at Biovici, said: "This collaboration between NPL, Swansea University's Centre for NanoHealth and our partners in China opens a unique opportunity to develop a low-cost, affordable test, which will bring major benefits to the global fight against the spread of this highly infectious disease. Many people associate hepatitis as a problem that happens elsewhere and not in their home country. However, hepatitis is a global epidemic which is rapidly affecting parts of the UK, throughout Europe and the USA."

Professor Owen Guy, Director (Engineering) at the Centre for NanoHealth at Swansea University, said: "Using semiconductor process technology applied to graphene enables us to make low-cost sensors. With the right lab-on-chip technology, there is the potential to develop sensors for a host of diagnostic and screening applications."

Provided by National Physical Laboratory