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The paper-thin printout piano that can play music thanks to ELECTRONIC INK

- Scientists from the University of Cambridge's Graphene Centre created the keyboard from graphene-based electronic ink printed on a plastic film
- They think graphene could be used in printed electronic devices such as heart monitors and other thin sensors
- The new material is cheap, environmentally stable and does not require much processing after printing in comparison to other conductive inks

By [Sarah Griffiths](#)

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Electronic ink printed on a plastic film has been used to make a transparent keyboard that can play music.

Scientists have demonstrated a new method of printing graphene-based ink on the flexible instrument, which they say could be used to make inexpensive printed electronics.

They believe graphene could be used in printed electronic devices such as heart monitors and other thin sensors.



The scientists designed their piano in collaboration with Novalia Limited. Here, a paper print-out of piano keys with the correct spacing, is placed beneath the plastic keyboard to make it look more conventional

WHAT IS GRAPHENE?

- Graphene is one of the crystalline forms of carbon, alongside diamond and graphite.
- In this material, carbon atoms are arranged in a regular hexagonal pattern.
- Graphene can be described as a one-atom thick layer of the layered mineral graphite.
- High-quality graphene is very strong, light, nearly transparent, and an excellent conductor of heat and electricity.
- Its interaction with other materials and with light, as well as its inherently two-dimensional nature, produce unique properties.

Dr Tawfique Hasan, Dr Felice Torrisi and Professor Andrea Ferrari at the University of Cambridge's Graphene Centre, invented the graphene-based ink and said just like graphene, the material has a number of interesting properties, including flexibility, optical transparency, and electrical conductivity.

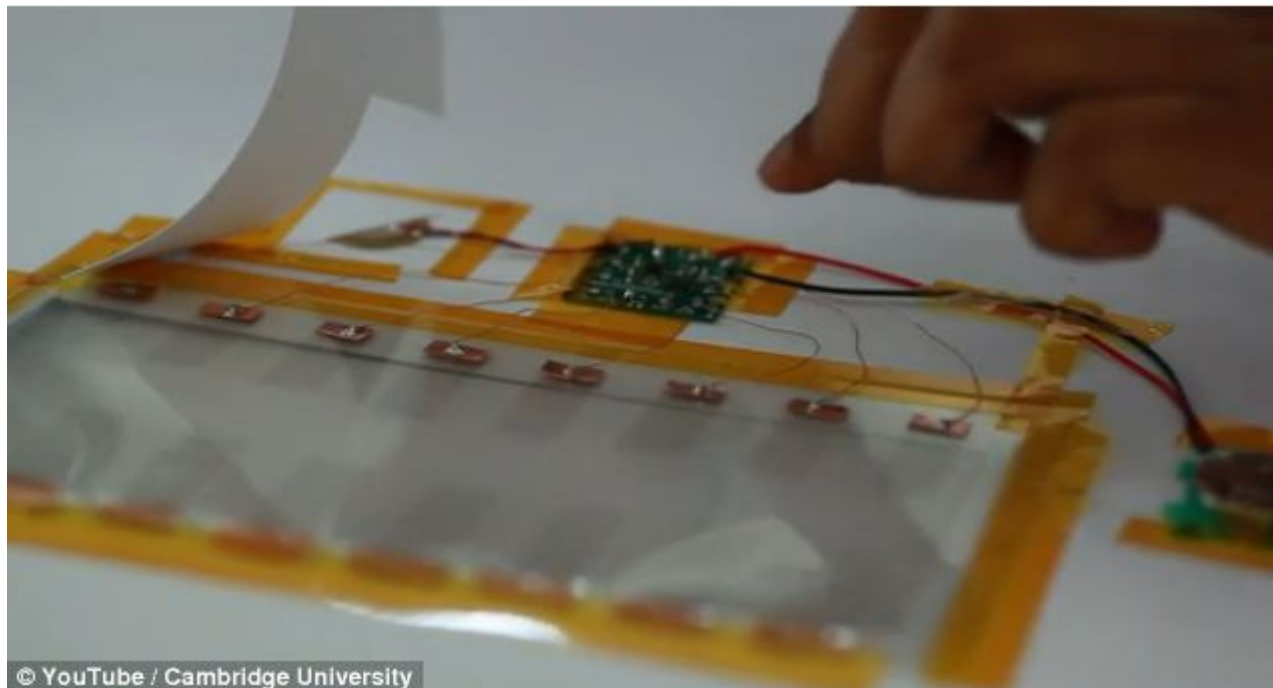
The scientists designed their piano in collaboration with Novalia Limited and its keys are made from graphene-based inks, which have been printed onto a plastic film.

These keys, working as electrodes, are connected to a simple electronic circuit-board, a battery and speaker.

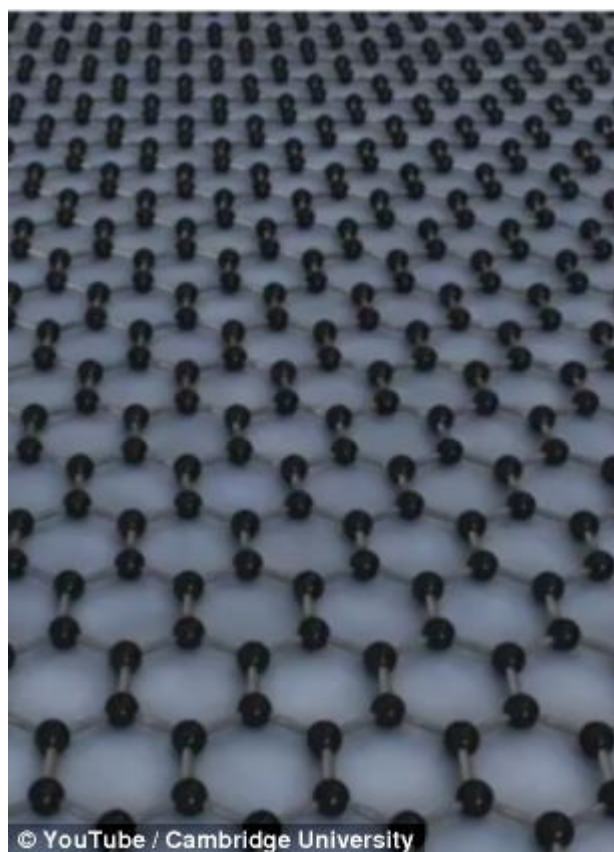
When a person touches a graphene electrode, the amount of electrical charge held in the key changes.

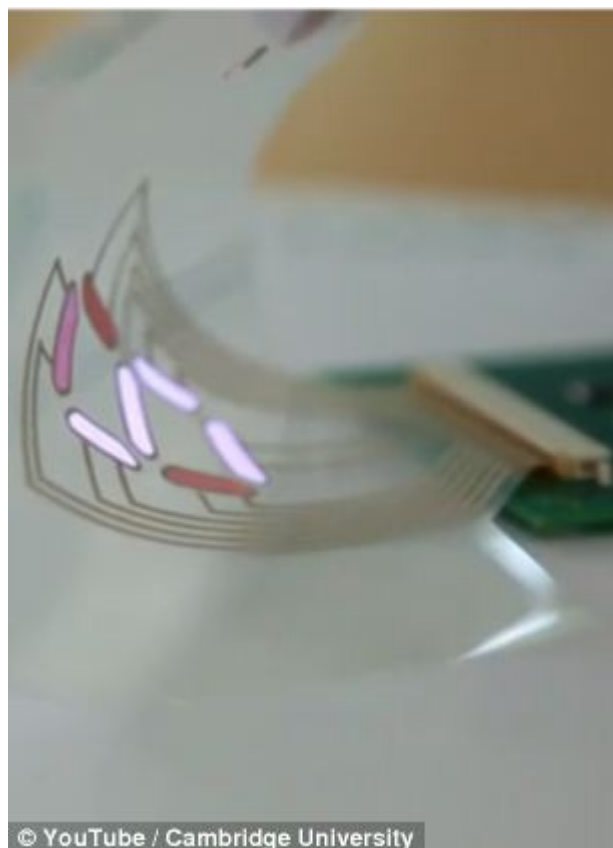
This is then detected and redirected by the circuit to the speaker, creating the musical note.

Other conductive inks are made from precious metals such as silver, which makes them very expensive to produce and process, whereas graphene is both cheap, environmentally stable and does not require much processing after printing.



This flexible piano is made from graphene-based inks, which have been printed onto a plastic film. The keys work as electrodes and are connected to a circuit-board, battery and speaker. When a person touches a graphene electrode, the amount of electrical charge held in the key changes and when it is detected it is redirected to the speaker to play a note





The scientists believe graphene could be used in printed electronic devices such as heart monitors and other thin displays (a prototype is pictured right). The flexible material is similar to graphene (pictured left) and has a number of interesting properties, including flexibility, optical transparency, and electrical conductivity

The scientists said graphene ink is superior to conductive polymers in terms of cost, stability and performance.

The research team have also developed a flexible prototype digital display, which uses conventional printable materials, but with a transparent, electrically conductive graphene layer on top.

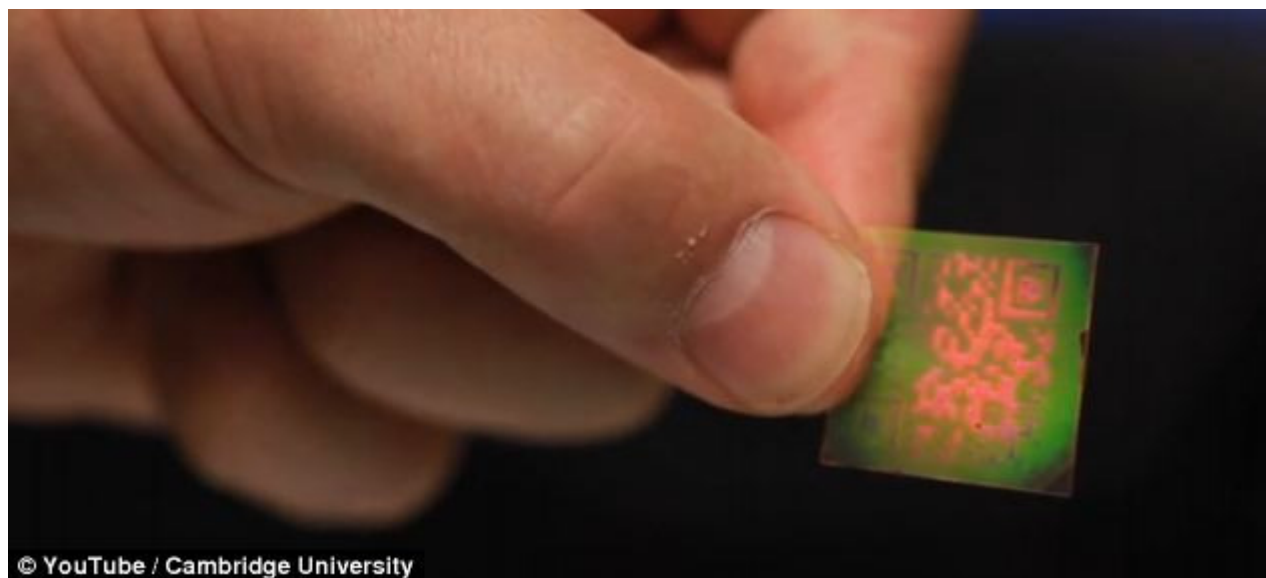
The graphene layer is not only flexible but also more conductive and transparent than the conventional polymer it replaces.

They believe the simple displays can be used in a wide range of smart packaging applications such as toys, labelling and board games.

'Both of these devices show how graphene could be printed on to a whole range of surfaces, which makes it ideal for printed electronics,' Dr Hasan, the lead researcher behind the prototypes, said.

'For example, it might eventually be possible to print electronics on to clothing and to make wearable patches to monitor people with health conditions, such as a heart problem,' he added.

Another potential application of the technology could be cheap, printable sensors, which could be used to track luggage around an airport to ensure it is loaded on to the correct plane, or to follow products across a production and supply chain, the team said.



Each printed laser (pictured) can be designed to give out its own, unique optical signature, which its team of creators hope will prevent the sale of counterfeit goods

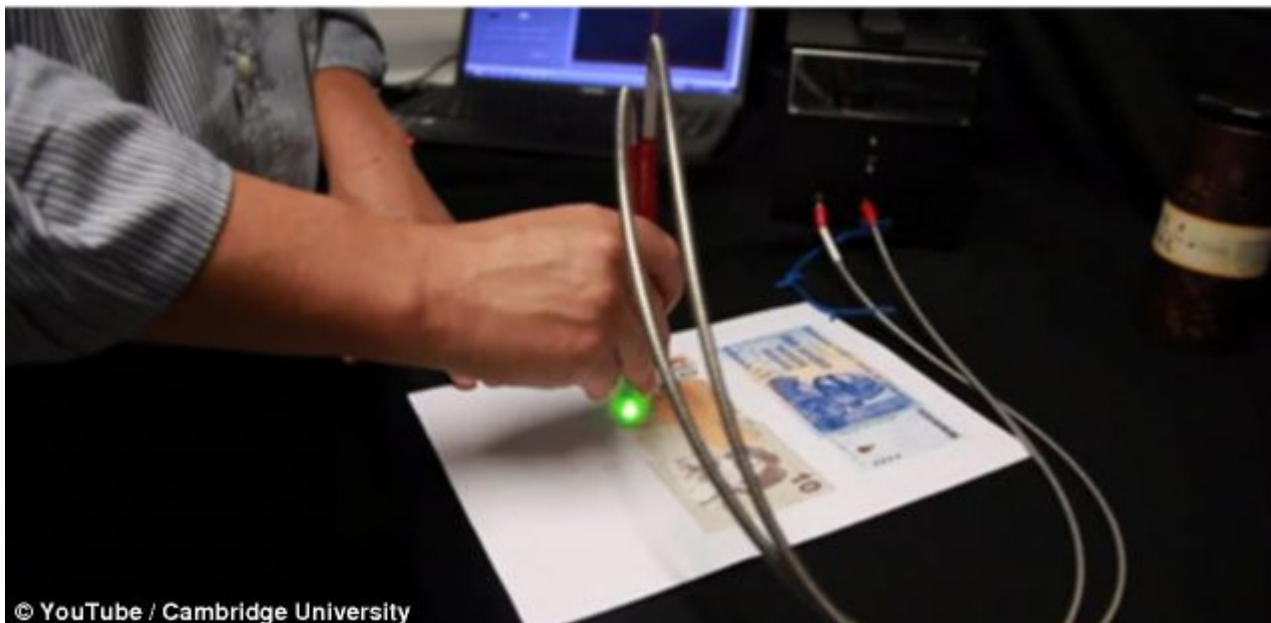
A separate team of researchers at the University has created a detection device that uses printed lasers to identify counterfeit goods, which could help make products ranging from banknotes to designer handbags more resistant to fraud.

Dr Damian Gardiner, who led the project, said the anti-fraud detector demonstrates an approach that could be employed to identify fake pharmaceuticals and currency, as well as high-value goods.

It works by exploiting an existing method for printing liquid crystal lasers with inkjet printers, which gives the user a very precise level of control over the laser's pattern and colour combination.

The detector takes advantage of this by shining a second, laser pulse onto the printed one.

It then reads the wavelength of the light emission from the printed laser through a piece of dedicated software and reproduces that reading as a pattern on a spectrograph.



Lasers can be printed on to all sorts of surfaces, including plastic, paper, metal and glass, the technique could be used to authenticate a wide range of products. Here a scientist demonstrates how the technology could be used to detect fake banknotes

The result is that each printed laser can be designed to give out its own, unique optical signature.

Because lasers can be printed on to all sorts of surfaces, including plastic, paper, metal and glass, the technique could be used to authenticate a wide range of products.

Dr Gardiner said: 'Every year, hundreds of thousands of people are sold fake pharmaceuticals under the mistaken belief that they will help them, while counterfeit products cost companies hundreds of billions of pounds.'

'We think that our printed lasers could be used to protect both products and people.'

The prototypes were developed within the University's Electrical Engineering Division and the teams are now working with partners in industry with a view to bringing them into commercial use.

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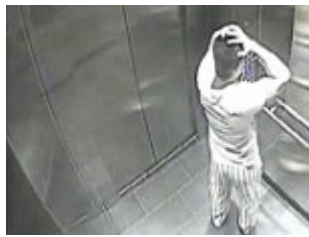
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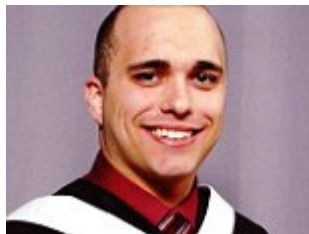
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[Old Eric](#), East Essex Engerland, United Kingdom, 1 day ago

I remember a stage entertainer on TV in the 60s or 70s who had a flat piano keyboard that he'd play, then roll up, put under his arm, and walk off stage. Obviously the "guts" of the device were concealed in the table, but the keyboard was printed on a roll of flexible paper or plastic.

0
2

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[josephspain](#), cadiz, 2 days ago

laser technology is great ----- but graphite technology has been used in flexible pcb for years now

2
0

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[Dan MDK Woking](#), Woking, United Kingdom, 2 days ago

Heres how it works British researchers prove idea, using money from British Tax payers, American Company buys idea and Patents it, Chinese Company makes it, another American Company Sells it it, but pays no Tax in UK. Until we start making stuff in the UK, what is the point of research, we are just a pool of Consumers for American Companies to exploit.

0
6

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[Bob](#), ukip land, United Kingdom, 2 days ago

electronic ink has been around for years a none story again, underneath every computer keyboard is a thin plastic membrane , with line on it,,,,,,,,,ELECTRONIC INK WAS USED TO PRINT THOSE LINES

2
1

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[josephspain](#), cadiz, 1 day ago

Bob, ukip land, United Kingdom ----- that too has been used for years in cable connections for video cameras and 20 years ago there was plastic pcbs with the chips encrusted and interconnections using conductive plastic and paint

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[willum1](#), Doha, 2 days ago

Well done U of Cambridge - now let's ship the idea to China and they can reap all the benefits in the future.

0
4

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[Pete](#), Shepherds Bush, United Kingdom, 2 days ago

Two copies, please... One for Keith Emerson and one for Rick Wakeman!

0
0

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[Cooking With Pooh](#), Pooh Ville, United Kingdom, 2 days ago

er, look inside a modern computer keyboard & you'll see exactly this already! introduced years ago

2
4

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[Resnam](#), Sandbanks, United Kingdom, 2 days ago

Pianos and electronic keyboards are supposed to be touch sensitive so a flat piece of paper will not be any good.

1
7

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[Trustnobody](#), Landofthefreeloaders, United Kingdom, 2 days ago

Do the notes sound flat?

0
18

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[Pete](#), Shepherds Bush, United Kingdom, 2 days ago

shaddap! 8-)

0
2

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[The Crusher does exactly what it says on the tin. Unleash an unrelenting torrent of deep bass through your eardrums. Be warned, these are not for the faint-hearted.](#)

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