



The research commercialisation office of the University of Oxford, previously called **Isis Innovation**, has been renamed **Oxford University Innovation**

All documents and other materials will be updated accordingly.
In the meantime the remaining content of this Isis Innovation document is still valid.

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Thin, flexible ultra-high resolution displays

Dr Richard Holliday describes display technology with flexibility, high resolution and low power requirements that make it ideal for portable devices such as phones and wearables

Electronic displays are ubiquitous, and the global display market is projected to reach \$165 billion by 2017. A recent Oxford discovery offers the chance to create a new class of ultra-high resolution, low-energy and flexible displays for applications such as 'smart' glasses and foldable screens. The research was recently published in *Nature*.

Phase change materials

A team from Oxford University's Department of Materials, which led the research, had been exploring the link between the electrical and optical properties of phase change materials, a unique class of materials that can reversibly change from an amorphous to a crystalline state. They found that by sandwiching a seven nanometre thick layer of a phase change material between two layers of a transparent conductor, a tiny current could be used to 'draw' images within the sandwich 'stack'. The phase change material used was the alloy $\text{Ge}_2\text{Sb}_2\text{Te}_5$ (Germanium-Antimony-Tellurium or GST), a material that is well-known in the electronics industry having been a key

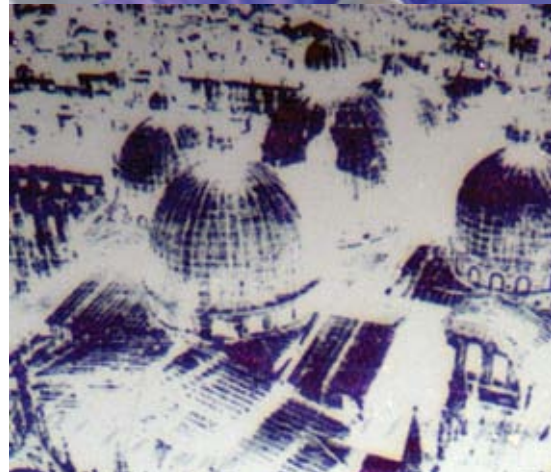
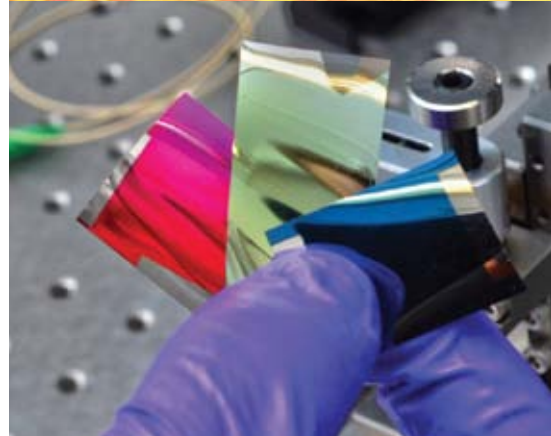
component enabling data storage on DVD and Blu-Ray discs.

Initially, still images were created using an atomic force microscope to switch the phase change material, but the team went on to demonstrate that such tiny 'stacks' can be turned into prototype pixel-like devices. These 'nano-pixels' – just 300 by 300 nanometres in size – can be electrically switched 'on and off' at will, creating the coloured dots that can form the building blocks of an extremely high-resolution display technology.

Flexible displays

A key advantage in using extremely thin films is their intrinsic mechanical flexibility. The same technology has been demonstrated to work on flexible Mylar sheets a few microns thick. This makes it potentially useful for 'smart' glasses, foldable screens, windshield displays, and even synthetic retinas that mimic the behaviour of photoreceptor cells in the human eye.

Another important feature related to display applications is that, unlike conventional LCD screens, there is no need to constantly



Example of an electrically constructed image, 70 μ m wide, on a phase change material optoelectronic film

refresh all pixels; you only have to refresh those pixels that actually change (static pixels remain as they were). This means that any display based on this technology would have extremely low energy consumption. In addition, flexible paper-thin displays based on the technology could have the capacity to switch between a power-saving 'colour e-reader mode', and a backlit display capable of showing video.

The advantages of this technology for projection micro-displays such as those used in the highly publicised "Google Glass" are exciting. A key requirement for this type of display is very high resolution as a small display is optically "projected" to create a viewable display. Such displays also need to be thin, light and consume very little power, especially when they are displaying static images to preserve battery life. This new technology is perfectly suited to such a market – it consumes no power when static, can be made at very high resolution and can be made ultra-thin and light.

Commercialisation

A patent application has been filed, a proof-of-concept already developed and work is now underway to upscale the number of pixels in a working display. Isis is now discussing the technology with investors and companies who are interested in developing the technology for future products.

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