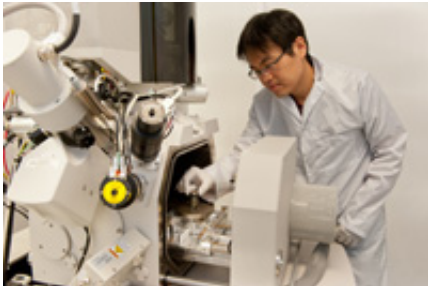# A new take on the Midas touch: Changing the colour of gold

October 24 2012

The tiny patterns are formed on the gold surface using a process called ion beam milling (the focused ion beam system is used to create nanoscale intaglio metamaterial patterns on the metal surface.

Red gold, green gold – a ground-breaking initiative has found a way of changing the colour of the world's most iconic precious metal.

A University of Southampton team have discovered that by embossing tiny raised or indented patterns onto the metal's surface they can change the way it absorbs and reflects light – ensuring our eyes don't see it as 'golden' in colour at all.

The finding results from a major initiative funded by the Engineering and Physical Sciences Research Council (EPSRC) targeting the development of a new generation of nanotechnology-enabled materials.

Equally applicable to other metals such as silver and aluminium, this

breakthrough opens up the prospect of colouring metals without having to coat or chemically treat them. This could deliver valuable economic, environmental and other benefits.

The technique could be harnessed in a wide range of industries for anything from manufacturing jewellery to making [banknotes](#) and documents harder to forge.

"This is the first time the visible colour of metal has been changed in this way," says Professor Nikolay Zheludev, Deputy Director of Southampton's Optoelectronics Research Centre, who led the project.

"The colours of the objects we see all around us are determined by the way light interacts with those objects. For instance, an object that reflects [red light](#) but absorbs other wavelengths will appear red to the [human eye](#).

"This is the fundamental principle we have exploited in this project. By embossing metals with patterns only around 100 nanometres across, we've found that we can control which [wavelengths of light](#) the metal absorbs and which it reflects." *

The precise shape and height or depth of the patterns determine exactly how light behaves when it strikes the metal and therefore what colour is created. The technique can be used to produce a wide range of colours on a given metal.

A silver ring, for example, could be decorated with a number of different patterns, making one part of it appear red, another part green and so on; metal features with sophisticated optical properties that would be almost impossible to imitate could be incorporated into documents as security features.

The nano-patterning is carried out at the research level using well-established techniques such as ion beam milling, which may be envisaged as sand-blasting on the atomic scale.

However, the concept may be scaled for industrial production using such processes as nano-imprint, whereby large areas are stamped out from a master template in a manner comparable to CD/DVD production.

"We've filed a patent application to cover our work," Professor Zheludev says, "and we're currently talking to a number of organisations about taking our breakthrough towards commercialisation."

  More information: J. Zhang, J. Y. Ou, N. Papasimakis, Y. Chen, K. F. MacDonald, and N. I. Zheludev, "Continuous metal plasmonic frequency selective surfaces" *Optics Express* 19, 23279 (2011) [doi: 10.1364/OE.19.023279]
J. Zhang, J. Y. Ou, K. F. MacDonald, and N. I. Zheludev, "Optical response of plasmonic relief meta-surfaces" *Journal of Optics* 14, 114002 (2012) [doi:10.1088/2040-8978/14/11/114002]
"Method and device for controlling the color of metals" (US patent application 13/182,084 (13/07/2011); GB application 1011720.8 (13/07/2010))

Provided by Engineering and Physical Sciences Research Council