THE HONG KONG POLYTECHNIC UNIVERSITY 香港理工大學
Institute for Entrepreneurship 企業發展院
Issue | Mar 2020

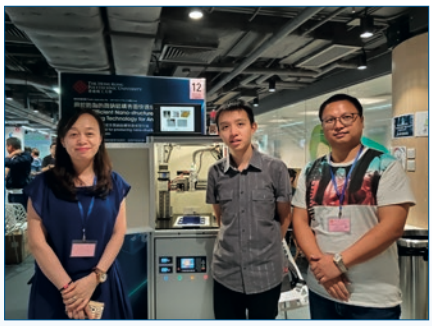
Technology Frontier

News Bite on PolyU's Innovation

Highly Efficient Nano-structure Patterning Technology for Anti-counterfeiting

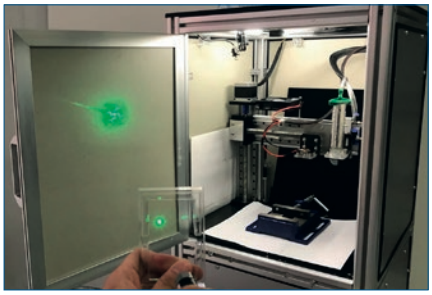
Easy to verify, difficult to forge

Nearly 10% of all goods sold worldwide are pirated or counterfeited. Bogus products and infringement of intellectual property pose a menace to global economy, national security and public health. Most anti-counterfeiting methods fail within one year or two as they are cracked by pirates swiftly. In light of this, researchers from the State Key Laboratory of Ultra-precision Machining Technology, the Department of Industrial and Systems Engineering, developed a nano-structure patterning technology for anti-counterfeiting that is easy to verify but difficult to forge, while keeping the cost low.

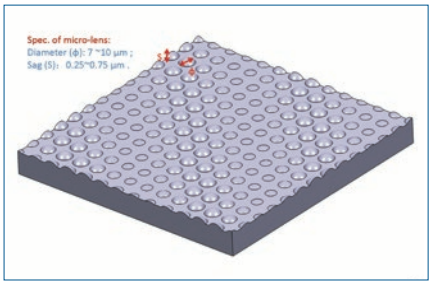


Prof. Sandy To (left) from the State Key Laboratory of Ultra-precision Machining Technology, the Department of Industrial and Systems Engineering, and her team members

All shoppers want to get what they pay for and no one wants to be scammed. Unfortunately, about 10% of all goods sold worldwide are pirated or counterfeited[1]. The problem seems to have worsened as online shopping gains traction. If you pay the full price of the real thing and get yourself a pirated brand name handbag or a pair of fake sneakers, you lose money. But if what you get are fake drugs, the loss could be irrecoverable. As many as 250,000 children die every year from taking fake or shoddy drugs to treat malaria and pneumonia alone[2]. Scientists and experts have been finding ways to combat counterfeiting, but most anti-counterfeiting methods don't last as they can be cracked within a year or two. In this regard, optical security devices such as holograms and nano-structure patterning techniques are useful as they enhance the level of security by making verification easy and forging difficult. Traditionally, nano-structure patterning is so expensive that only the most valuable luxury brands can afford to use it. Therefore, Prof. Sandy To from the State Key Laboratory of Ultra-precision Machining Technology, the Department of Industrial and Systems Engineering, led a research team to develop a low-cost nano-structure patterning technology for anti-counterfeiting. Brand owners may then provide their consumers with the ultimate peace of mind.



The specially designed pattern created by the Nano-structure Patterns Production Device can only be shown through projection with a laser beam



Schematic diagram of a nano-structure pattern

The highly efficient nano-structure patterning technology for anti-counterfeiting won a Gold Award and an Outstanding Ultra-Precision Engineering Award in Asia International Innovative Invention Award 2019.

Conventional nano-structure patterning

Traditionally, nano-structure patterning is achieved by photolithography which entails long production cycles. "The cost of photolithographic equipment for producing nano-structure patterns is high, which is not affordable to every manufacturer. In addition, through photolithography the pattern is transferred from the master to a substrate by applying a photoresist agent. Since a nano-structure pattern is a multilayer structure and the manufacturing process needs to be completed by repeated photolithography, it is almost impossible to shorten the production cycle and boost productivity," explained Prof. To.

Diffraction optical element

Therefore, the team developed a novel nano-structure patterning technology and equipment – a transparent UV-sensitive film is sprayed onto the target product, and then embossed with a nano-structure pattern using a mould that is encoded with diffraction optical element (DOE). Ultraviolet light is applied on the film to cure and harden it. The pattern is then imprinted permanently on the surface. "First of all, the nano-structure cannot be lifted and grafted to something else. The film is only a few microns thick and almost invisible to human eyes. Any attempt to remove it would break it and make it unreusable. Secondly, the nano-structure pattern is encrypted with DOE by means of advanced optical design, so that it is extremely difficult to counterfeit. A trademark or pattern is transformed into DOE which is composed of multiple micro/nano structural layers unrecognisable to naked eyes. The image can only be re-formed when a laser beam of specific wavelength is projected through the nano-structure. The team can design any logo or pattern that fits the needs of customers and products. The design process is highly confidential and requires special knowledge, thus the nano-structure patterns are almost impossible to duplicate. Thirdly, the mould of DOE is made by a special ultra-precision machining technique developed by the team. This process not only requires ultra-precision machining equipment, but also special machining processes. Hence, this technology has an outstanding anti-counterfeiting effect." said Prof. To.

As this technique does not require etching and ultra-precision machining during mass production, the production cycle is considerably shorter than the traditional method. The initial capital cost is also kept low as the production equipment costs lower than photolithographic equipment. Prof. To said, "We hope to popularise the use of optical security devices and laser surface authentication with this technology to safeguard the authenticity of consumer products and documents."

In November 2019, the highly efficient nano-structure patterning technology for anti-counterfeiting won a Gold Award and an Outstanding Ultra-Precision Engineering Award in Asia International Innovative Invention Award.

[1] *"Fighting counterfeiting at the nanoscale." 5 June 2019. Nature Nanotechnology. Retrieved from https://www.nature.com/articles/s41565-019-0484-0*

[2] *Sample, Ian. "Fake drugs kill more than 250000 children a year, doctors warn." 11 Mar 2019. The Guardian. Retrieved from https://www.theguardian.com/science/2019/mar/11/fake-drugs-kill-more-than-250000-children-a-year-doctors-warn*