Light Nanotechnology and Counterfeit Prevention

**ABSTRACT**
Clint Landrock, an engineer and inventor from British Columbia, developed a unique anti-counterfeiting method based on nanotechnology. His discovery may soon replace the holograms that are currently used to protect banknotes and other documents from forgery. Landrock’s technology uses tiny “nanoscopic” perforations, each 1/1500 the size of a human hair, that reflect and refract light. These nanostructures produce a unique shimmering iridescence, and, unlike a hologram, they cannot be duplicated or copied.

**Current Anti-Counterfeiting Technology**
Since the late 1970s, many industries and governments have used holograms as a security measure to prevent counterfeiting. For instance, the shimmering circles of film on sports-league items, which prove they are authentic, are holograms (Figure 1). However, counterfeiters have discovered ways to duplicate holograms, so they are no longer effective security measures.

Researchers were able to overcome this problem after the development of lasers in 1960. Emmett N. Leith and Juris Uapatiens split a laser beam and illuminated an object with one part of the beam and directed the other part of the beam to a photographic plate or film. When the light from both beams interfered on the surface of the film, the film recorded the pattern (Figure 2). The film appeared to contain grey smudges when viewed in white light. However, when Leith and Uapatiens illuminated the pattern with the same laser light, they saw a true three-dimensional image.

Dennis Gabor invented holography in 1947. Holography is a way to produce a three-dimensional image on a single film. Gabor assumed that light waves reflecting from various points on an illuminated object interfere with each other. He hypothesized that photographing the interference patterns coming from an illuminated object would produce a three-dimensional image of the object. Using white light, Gabor demonstrated that his idea works. However, white light is incoherent because it contains a wide range of frequencies. As a result, the images Gabor produced were fuzzy.

Holograms have worked effectively for decades as security measures. In the past few years, the cost of holographic printers has decreased. As a result, counterfeiters have become more skilled at duplicating security holograms.

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**Figure 1** Holograms are used to validate the authenticity of many sports-league items.

**Figure 2** A laser beam is split into two beams. The resulting interference patterns are then recorded on film, creating a three-dimensional image.
Inspiration from Nature

During a trip to Costa Rica, Clint Landrock, an engineer and inventor from British Columbia, was inspired by the blue morpho butterfly (Figure 3). The blue morpho has tiny perforations in its wings that reflect and refract light to give the butterfly a shimmering, iridescent appearance (Figure 4).

Figure 3 The iridescent wings of a blue morpho butterfly show luminescence.

Figure 4 This scanning electron micrograph image shows the tiny perforations in the blue morpho’s wings. It is these perforations, and not a pigment, that produce an iridescent effect.

A few years later, while studying solar cells at Simon Fraser University in British Columbia, Landrock remembered the blue morpho butterfly and how it reflected and refracted light. He noticed that thin metal sheets containing tiny perforations created iridescence, just as the wings of the blue morpho butterfly do. The iridescent light from the metal sheets reflects as a beam of pure colour, just as light from a blue morpho’s wings reflects as a brilliant blue colour. Landrock and his colleagues realized that these unusual properties could be developed into a technology that prevents counterfeiting in banknotes and passports. They contacted a number of international banks, including the Bank of Canada, and the research team is in the process of marketing this new technology.

The Science behind the Technology

This new process is a combination of nanotechnology (the study of manipulating matter on an atomic and a molecular scale) and entomology (the study of insects). The technology is simple: drill numerous, tiny holes about 1/1500 the thickness of a human hair in thin pieces of metal and illuminate the metal. The resulting colour, like the iridescence of the blue morpho butterfly, comes from the reflection and refraction of the light, not from inks, dyes, or pigments. Since no colour pigment exists, the counterfeit mark cannot be copied or scanned. Furthermore, the minuscule size of the perforations makes them almost impossible to replicate. The technology is called nano-optic technology for enhanced security (NOTES).

Applications

According to the inventors of NOTES, preventing counterfeit banknotes and passports is just the beginning. There will be many other practical applications, from authenticating legal documents and stock certificates to preventing counterfeit pharmaceuticals. In fact, the inventors hope to replace holograms in a variety of merchandise, including sports brands, running shoes, and DVD software.

Further Reading


WEB LINK

10.7 Questions

1. What concepts related to the wave nature of light apply to nanotechnology? Explain one of these concepts and how it applies to the technology.

2. Explain how butterfly wings reflect light to produce vivid colours.

3. Research the future implications of nanotechnology in optics. Summarize your findings in a short list.

4. In a graphic organizer, compare holography and nanotechnology in terms of the counterfeiting application.

5. How does this application of nanotechnology demonstrate the roles of creativity and chance in science?

6. How does this application of nanotechnology demonstrate the link between science and technology?