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Fabrication of Large Area, Highly-flexible Metamaterials and its Potential Application for Organic Electronics

Source Link:
https://www.youtube.com/watch?v=X1ZPNxLlpu0

Source Link:
http://www.flickriver.com/photos/tonyworrall/tags/car/

❖ Introduction

Over the past decade, the development of metamaterial has been arousing many interests due to its large variety of applications. For example, metamaterial has been proposed for optical cloak, illusion absorber, and negative index materials in which the electromagnetic response could be engineered by scaling the size parameter of the artificial structures. Furthermore, the shape of the metamaterial device is also an important parameter for manipulating the light scattering. The optical cloak and hyperlens fabricated with curved structure is an example that has been applied to modulate the anisotropic refractive index. In addition, metamaterial and plasmonic devices on flexible tape, silk, paper and stretchable polydimethylsiloxane (PDMS) substrate have been demonstrated to show unusual optical response. However, most of the reported flexible metamaterial or plasmonic devices can only work in Gigahertz, Terahertz, or Far-infrared frequency. For near-Infrared (NIR) and visible wavelength applications, the feature size of each unit cell has to be scaled down to tens of nanometer. Most of the current optical metamaterial nanostructures were fabricated on rigid substrate such as glass, silicon and they are usually made by the techniques such as focus ion beam (FIB), e-beam Lithography (EBL), nano-imprint lithography (NIL) and soft interference lithography (SIL). These methods allow excellent control on wide range of patterns; however, the processes are very slow for limited sample size.

Single layer flexible metamaterial working at the range of visible to NIR wavelength has been reported recently and this can be directly fabricated on polyethylene terephthalate (PET) substrate using EBL. However, the chemical solution used for metal lift-off process has a stringent requirement to prevent damages on the flexible substrate. Besides, the uneven surface of PET substrate brings additional difficulty in focusing electrons in EBL process that results in poor uniformity. For nanometer printing technique, the major issue of producing three dimensional flexible metamaterial with a large area very challenging due also to the relative softness of PET.

This invention introduces a laser interference lithography technique for fabrication of flexible metamaterial or plasmonic nanostructure in a large area, which has potential applications such as imaging and environmental sensors. Because of its high flexibility, the metamaterial or plasmonic sensor can be conformed into different shapes and can be adopted as gas sensor. For example, toxic gas leakage can be detected by a sensor in a small pipe in the enclosed and tight area.

❖ Key Features

- High throughput
- High production yield
- Very cost effective for large-scale production
- Easy for production

❖ Application

The invention has wide applications such as optical cloak, illusion absorber, gas sensor, etc.

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Method and apparatus for measuring amount of materials removed from target in pulsed laser ablation

❖ Introduction

Laser ablation is the process to remove materials from a solid surface by laser beam irradiation. It can be used for machining, drilling, cleaning the surfaces and removing paints or coating without damaging the underlying surface.

In the past, the small amount of materials removed in pulsed laser ablation was typically determined by depositing them on a quartz microbalance and measuring the shift in the quartz oscillator frequency. The method had many shortcomings: the instrumentation is costly, the smallest mass it can measure is fractions of nano-gram, and it generally requires operation in vacuum. Therefore, an inexpensive method with mass sensitivity down to tens of pico-gram and compatible with ambient air is desired.

This invention provides a new method and apparatus, which utilizes acoustic signal to measure the mass of removed materials from the surface. This measurement can be conducted in real-time and workable on different kinds of materials such as aluminum and PVC. This invention can also be applied to solve real-world problems such as laser refractive surgery.

❖ Key Features

- Low cost
- Good reliability and very easy to control
- High mass sensitivity (i.e. down to tens of pico-gram)
- Compatible with ambient air

❖ Application

The present invention can be applied to machining and drilling on dedicated area like tooth enamel and corneal refractive surgery. For instance, with proper calibration, LASIK surgery can be done precisely to prevent cornea over-removal.

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Ultra-hard Anti-Scratch Thin Film

❖ Introduction

In the past few years, smart phones and tablets are very popular and common in the world. So far, the current screen material use as window cover or cover screen is Gorilla Glass (GS) from Corning, which is being used in over 2.7 billion devices. However, the latest GS only scores 6.5 on the Mohs scale of mineral hardness, which is still easy to get scratches by sand and steel. When comparing to GS, Sapphire is harder and being recognized to be the second hardest naturally occurring material, behind diamond. So, in this recent year, Sapphire is being considered to replace the existing screen material including GS.

Sapphire window has already been featured on iPhone 5S TouchID scanner and camera lens on the rear of the phone while Vertu the luxury smartphone manufacturer, Huawei and Kyocera are also developing this related technology. But in general, high hardness materials are also fragile or brittle.

The present invention introduces a novel technology to produce thin film material with high hardness but without scarifying the mechanical performance. The hardness is comparable to that of bulk sapphire. Furthermore, the manufacturing cost can be significantly reduced when comparing to the existing fabrication method due to shorter processing time and ease of large-scalability.

❖ Key Features

- Ultra-high highness with good mechanical properties
- Low manufacturing cost

❖ Application

The established technology can provide an ultra-high anti-scratch film for the cover screen or window covers for smartphone or tablets applications.

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