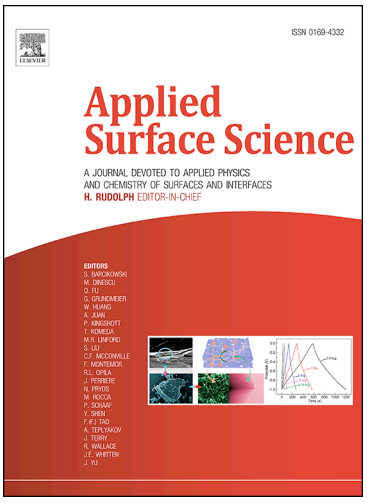

Full Length Article

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UV Laser annealing of Diamond-Like Carbon layers obtained by Pulsed Laser Deposition for optical and photovoltaic applications.

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Abstract

One of the biggest challenge in optoelectronic devices is the necessity to provide a viable and reliable alternative to Transparent Conducting Oxide (TCO) and especially to Indium Tin Oxide (ITO). Graphene is a widely studied material and one of the best alternative to be used as conductive and transparent electrodes. It is well known that the difficulty to transfer graphene on another substrate is a serious limitation for its use on large scale devices. In this work, we explore Diamond-like Carbon (DLC) thin films prepared by Pulsed Laser Deposition (PLD) to be used as substrate for graphene-like layers. DLC thin films are excellent candidates due to their visible-range transparency being also a very good electrical insulator. Transmission measurements show the UV opaque character of the DLC layers, independently to the experimental parameters used to produce them. Thus, top-hat UV laser surface annealing can strongly modify the DLC thin film structure in order to bring conductivity to the first atomic layers. Raman spectroscopy and X-ray photoemission spectroscopy permit to confirm the graphitic character of the DLC surface. Optimizing PLD as well as laser annealing parameters is explored in detail in order to obtain comparable performances (conductivity and transparency) to ITO typical properties. Moreover, using a full-based laser process offers a complete compatibility with all technical steps of the microelectronic domain.

Keywords

Pulsed Laser Deposition (PLD), Diamond-Like Carbon (DLC), Optoelectronic properties, Laser surface annealing.

1. Introduction

The most common transparent conductive material used nowadays in optoelectronic and photovoltaic devices is Indium Tin Oxide (ITO). This one owns very high transparency in the visible range and very high conductivity over large areas [1-2]. In the forthcoming years, we will face an increasing problem due to the indium rarefaction. Moreover, the impossibility of correctly recycling ITO is doomed to be a problem for the optoelectronic and photovoltaic components. A suitable alternative to this metallic oxide is needed. The hereby proposed solution is fully compatible with all the materials and processes used in micro and optoelectronics.

The Diamond-Like Carbon (DLC) is a material introduced nowadays in photovoltaic modules as encapsulation and protective anti-reflexion coating [3-4]. DLC is an amorphous form of carbon used as a low-cost substitute to diamond. This material is a very good electrical insulator due to kinship with diamond [5-7]. DLC is constitute by a mixture of sp^2 and sp^3 bounded carbon atoms [8]. Sp^2 is the stable binding corresponding to graphitic material whereas the sp^3 is the metastable binding related to the adamant character which is formed under special conditions of temperature and pressure. The amount of each carbon hybridisation and correlated properties are directly related to the process used to elaborate DLC [9-11]. Another important property that DLC share with diamond is a high visible