Optical Materials xxx (2016) 1–7

Contents lists available at ScienceDirect

Optical Materials

journal homepage: www.elsevier.com/locate/optmat

Silicon carbide thin films with different processing growth as an alternative for energetic application

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A R T I C L E I N F O

Article history:
Received 17 April 2016
Received in revised form
6 September 2016
Accepted 8 September 2016
Available online xxx

Keywords:
Silicon carbide
Thin films
Plasma
Crystalline structure
Amorphous films

A B S T R A C T

Different SiC thin film structures were obtained depending on the deposition techniques. Crystalline films were grown using a Pulsed laser deposition (PLD), in contrary the sputtering DC magnetron method allow to have an amorphous films (a-SiC:H and a-$Si_{1-x}C_x$:H). A comparative study of the structural and optical characteristics of the elaborated films has been performed. The energetic application possibilities such as blue or multicolor LEDs have been explored. Different techniques have been used to investigate the elaborated films such as SEM-EDS, SIMS, photoluminescence and spectral response.

1. Introduction

Silicon carbide has been attracted much attention in recent years because of its potential application in many kinds of opto-electronic devices, such as solar cells, images sensors [1–3], gas sensors [4] and photodiodes [5], applications in optics (earth observation) [6,7], Micromachined SiC optic fiber as pressure sensors for high-temperature aerospace applications [8] and SiC-SiC composites optics for UV applications [9]. The silicon carbide (SiC) has become the focus of considerable attention due to its excellent material properties, promising it for different applications. Several reports on p-type SiC were published, but not much effort has been focused on a hot-pressed 6H-SiC material with granular structure or on different structure of crystalline or amorphous thin SiC films [10–13]. To date no works have been performed on low-doped polycrystalline 6H-SiC and no chemical polishing solution has been developed on the material [14,15]. In this paper, we present results on elaborate thin silicon carbide films by the PLD and sputtering DC magnetron and thin SiC films, then the application of SiC thin films as a gas sensor. In the first part of the work, we describe a comparative study of the structural and optical properties of polycrystalline silicon carbide (6H-SiC) and SiC thin films grown onto p-type (100) silicon by pulsed laser deposition (PLD) using 6H-SiC as a target and p-type Si(100). Then, we demonstrated the interest and the application of SiC in Schottky photodiode based onto SiC thin films [16,17].

2. Experimental procedure

The measurements presented here were performed on square samples (10 × 5 mm^2) cut from an unpolished 6H–SiC wafer of 2 mm thickness with a resistivity of 30 kΩcm. The deposition of SiC thin films by Pulsed Laser Deposited (PLD) method has been described in our previous work [17,18]. The thickness of the deposited layers was varying by remote the deposition time. The

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http://dx.doi.org/10.1016/j.optmat.2016.09.027
0925-3467/

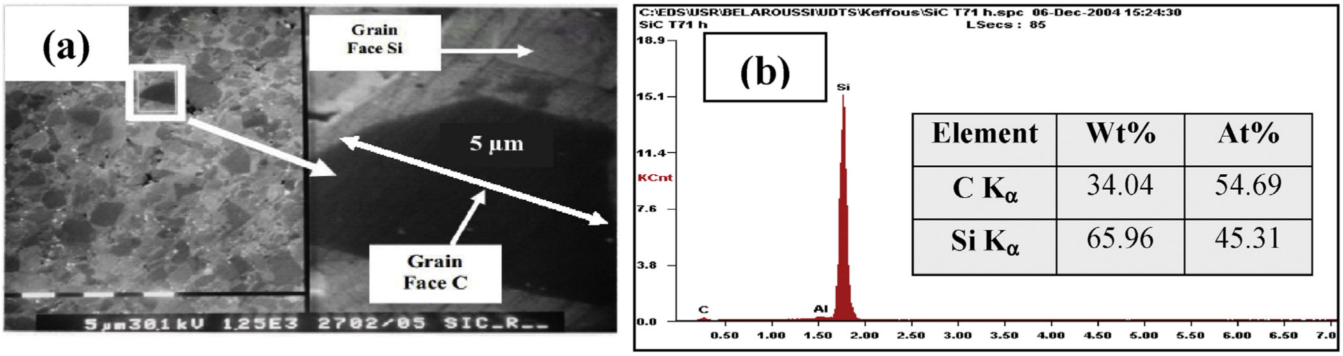

Fig. 1. Plan view SEM image **(a)** and EDS Spectra of polished polycrystalline 6H-SiC **(b)**.

amorphous a-$Si_{1-x}C_x$:H films were prepared in a sputtering DC magnetron system using 32–86 chips of a silicon carbide (6H–SiC) of 10 mm × 5 mm placed onto a high pulverisation region of single monocrystalline silicon as a target. The polycrystalline 6H–SiC chips were cut from a hot-pressed wafer (supplied by Goodfellow) and radially fixed on silicon target. The a-$Si_{1-x}C_x$:H thin films of 0.2–1.8 μm thicknesses were deposited on single crystalline silicon(100) wafers and corning glass 9075, which were cleaned with ethanol before deposition. Deposition rate of 2 Å/s was achieved in argon and hydrogen plasma mixture, using an operating pressure of 1 10^{-5} mbar with constant gas flow rates of 10 and 2 sccm for H_2 and Ar, respectively. The atomic hydrogen is used for its important role in controlling the film network and in turns the physical properties of amorphous semiconductors [14]. All samples were deposited with a 130 W power and temperature deposition of almost 300 °C. To investigate the structural properties, the samples were analysed with scanning electron microscopy "SEM-EDS" (*JEOL JSM 6360LV*), secondary ion mass spectrometry "SIMS" (*CAMECA 4FE7-CRTSE-Algiers*) and photoluminescence "PL" Perkin Elmer Spectrometer LS 50B″ for optical properties were used. After the elaboration of a-SiC:H thin films, an ohmic Aluminum contact is realized on the rear p-Si(100) substrate, then the samples were placed into a deposition chamber in order to evaporate a thin gold layer (99.995% purity) on the a-SiC:H/p-Si to form a Schottky contact. The thickness of the gold layer measured by a Tencor 250 profilometer was 250 nm. The spectral response (SR) measurements were carried out by using a tungsten filament lamp with an incident power (P_{inc}) of 170 Watts with a *JOBIN YVON monochromatic* in the range 350–1000 nm wavelength [19,20].

3. Results and discussion

3.1. Structural properties

3.1.1. SEM observations

Fig. 1 depicts a SEM plan view of the polished bare 6H-p-type SiC

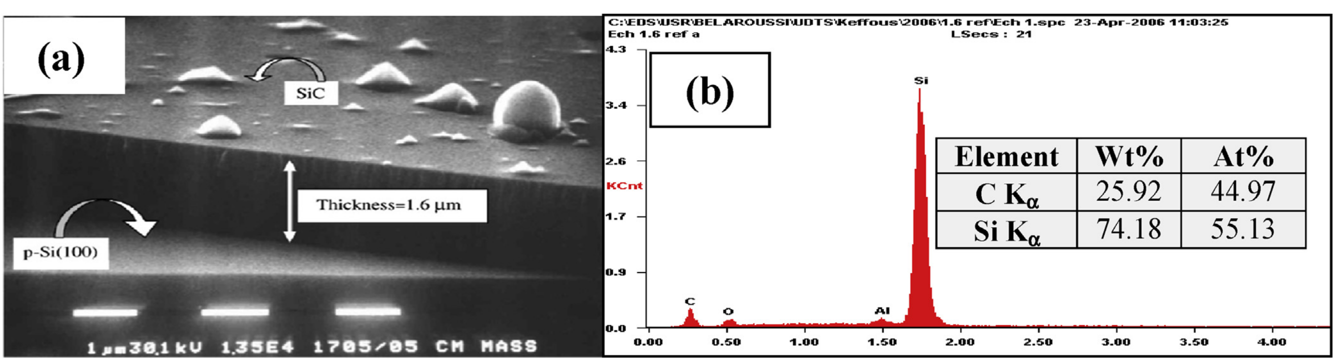

Fig. 2. Cross sectional, plan view SEM image **(a)** and EDS Spectra of c-SiC thin film.

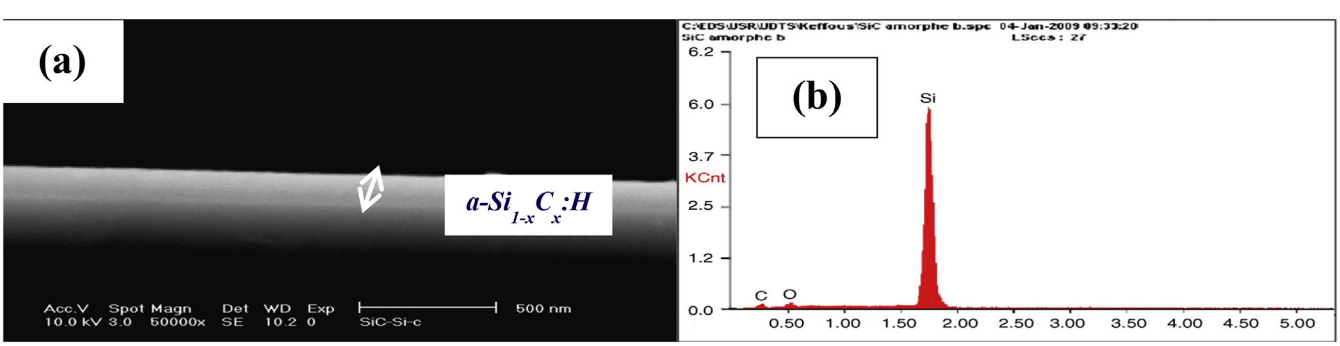

Fig. 3. Cross sectional, Plan view SEM image and EDS spectra of a-$Si_{1-x}C_x$:H thin film.