$Ti_{(1-X)}Si_XO$ FILMS PREPARED BY PLASMA ENHANCED CVD AND ATOMIC LAYER DEPOSITION

ZAJÍČKOVÁ Lenka, GOULLET Antoine, ELISABETH Stephane, ELIÁŠ Marek, RICHARD Mireille, ONDRAČKA Pavel, NEČAS David, GAUTIER Nicolas, GRANIER Agnes

Masaryk University, Brno, Czech Republic, EU
University of Nantes, Nantes, France, EU

Abstract

TiO2 has high dielectric constant (30-100) and refractive index (2.5<n<2.9 at 593nm) combined with high transparency in visible. Therefore, it is a good candidate for the development of high density capacitors in planar integrated device and for designing optical integrated waveguides or optical devices. However, some engineering is still necessary to overcome TiO2 intrinsic limitations. Columnar morphology is generally observed in TiO2 thin films prepared by vapor deposition techniques. It leads to increased optical losses and degradation of electrical insulating properties. In addition, its rather low band gap (~3.2eV) imposes also a limitation for reaching low leakage current. In the present work we study plasma enhanced chemical vapor deposition (PECVD) and atomic layer deposition (ALD) of Ti(1-x)SixO2 materials that can overcome some of the limitations given by TiO2 material. PECVD of Ti(1-x)SixO2 thin films was carried out in inductively coupled plasma using titanium tetraisopropoxide Ti(OC3H7)4 (TTIP) and hexamethyldisiloxane SiO2(CH3)6 (HMDSO) vapors mixed with oxygen. Different Ti/Si ratio in the films was achieved by varying the flow rates of TTIP and HMDSO. Addition of Si precursor led to the suppression of film columnar structure and XRD amorphous Ti(1-x)SixO2 material but still the question about mixing TiO2 and SiO2 materials remains. Characterization techniques suggest that there are a few nanometers domains of TiO2 and SiO2. Ti(1-x)SixO2 films were also obtained by ALD combining cycles with tetrakis(dimethylamido)titanium and tris(dimethylamino)silane for Ti and Si monolayers, respectively, with oxidizing step. The process was enhanced by plasma and the substrate temperature was 250oC.

Keywords: Titanium dioxide, ternary oxides, PECVD, ALD

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