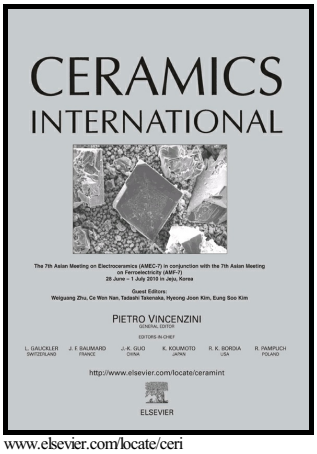
Bipolar resistive switching characteristics of silicon carbide nitride (SiCN)-based devices for nonvolatile memory applications

Narendra Singh, Kirandeep Singh, Davinder Kaur



www.elsevier.com/locate/ceri

PII: S0272-8842(17)30643-0
DOI: http://dx.doi.org/10.1016/j.ceramint.2017.04.037
Reference: CERI15017

To appear in: *Ceramics International*

Received date: 16 January 2017
Revised date: 23 March 2017
Accepted date: 6 April 2017

Cite this article as: Narendra Singh, Kirandeep Singh and Davinder Kaur, Bipola resistive switching characteristics of silicon carbide nitride (SiCN)-based device for nonvolatile memory applications, *Ceramics Internationa* http://dx.doi.org/10.1016/j.ceramint.2017.04.037

Bipolar resistive switching characteristics of silicon carbide nitride (SiCN)-based devices for nonvolatile memory applications

Narendra Singh, Kirandeep Singh, and Davinder Kaur

Functional Nanomaterials Research Lab, Department of Physics and Center for Nanotechnology, Indian Institute of Technology Roorkee, Roorkee 247667, India

*Corresponding author: Tel.: 91-1332-2285407; FAX: 91-1332-273560. E-mail: dkaurfph@iitr.ac.in;

Abstract-

The present study reports silicon carbide nitride (SiCN) as a new material for resistive switching-based nonvolatile memory device applications. The Cu/SiCN/Pt device exhibit uniform and stable bipolar resistive switching behavior. A thorough current-voltage (I-V) analysis suggests an Ohmic conduction mechanism within the low resistance state (LRS), whereas within the high resistance state (HRS) trap-controlled modified space charge limited conduction (SCLC) mechanism was found to be dominated. The resistance vs. temperature measurement (R-T curve) within LRS and HRS along with a model analysis indicates an interesting result that the formation of conduction path during LRS is not due to Cu filament but may be formed by trap-to-trap hopping of electrons via nitride-related traps between the top and bottom electrodes. The resistive switching in Cu/SiCN/Pt device was operated via electron transport path formation/rupture by electron trapping/de-trapping. The reliability of device was measured in terms of endurance and retention, which exhibits good endurance over 10^5 cycles and long retention time of 10^4 s at room-temperature as well as at 200 °C. The above result suggests the feasibility of Cu/SiCN/Pt devices for futuristic nonvolatile memory application at high temperature and harsh environment.

Keywords- Silicon carbide nitride, Electrode, Resistive switching, Thin films, Conduction.

1. Introduction

The conventional charge storage-based random access memory (RAM) has reached to its down-scaling limitation leading to reliable difficulties [1, 2]. In recent years next-generation nonvolatile resistive random access memory (ReRAM) has been studied extensively due to its excellent performance such as low power consumption, high-speed operation, high-density integration, down-scaling, and back end of line compatibility [3-5]. Resistive switching (RS) phenomenon has been studied in a variety of materials, such as ferromagnetic oxides and metal oxides [6, 7]. Recently, RS behavior of the nitride-based materials such as AlN, WN, CuN, SiN, ZrN, and NiN have received special interest due to their low operating current/voltage, fast program operation, and good compatibility