

Ge-doped Hafnia-based Dielectrics for Non-Volatile Memory Applications

To cite this article: Larysa Khomenkova *et al* 2012 *Meet. Abstr.* **MA2012-01** 731

View the [article online](#) for updates and enhancements.

You may also like

- [Electrical Characteristics of \$\text{HfO}_2\$ and \$\text{La}_2\text{O}_3\$ Gate Dielectrics for \$\text{In}_{0.53}\text{Ga}_{0.47}\text{As}\$ MOS Structure](#)
Kiyohisa Funamizu, Yueh Chin Lin, Kuniyuki Kakushima et al.
- [ALD and AVD Grown Perovskite-type Dielectrics for Metal-Insulator-Metal Applications](#)
Christian Wenger, Mindaugas Lukosius, Tom Blomberg et al.
- [Physical and Electrical Properties of MOCVD and ALD Deposited \$\text{HfZrO}_4\$ Gate Dielectrics for 32nm High Performance Logic CMOS SOI Technologies](#)
Torben Kelwing, Andreas Naumann, Martin Trentzsch et al.



Your Lab in a Box!

The PAT-Tester-i-16: All you need for Battery Material Testing.

- ✓ All-in-One Solution with integrated Temperature Chamber!
- ✓ Cableless Connection for Battery Test Cells!
- ✓ Fully featured Multichannel Potentiostat / Galvanostat / EIS!

www.el-cell.com +49 40 79012-734 sales@el-cell.com

EL-CELL®
electrochemical test equipment



Ge-doped hafnia-based dielectrics for non-volatile memory applications

L. Khomenkova^{1,4}, X.Portier¹, M. Carrada², C. Bonafos², B.S. Sahu³, A. Slaoui³ and F. Gourbilleau¹

¹CIMAP, CEA/CNRS/ENSICAEN/UCBN,
6 Boulevard Marechal Juin, 14050 Caen Cedex 4, France

²CEMES/CNRS, Université de Toulouse
29 rue J. Marvig 31055 Toulouse Cedex 4, France

³InESS, ULP/CNRS,
23 Rue du Loess BP 20, 67037 Strasbourg, France

⁴V.Lashkaryov Institute of Semiconductor Physics,
National Academy of Sciences of Ukraine,
45 Pr.Nauky, 03028 Kyiv, Ukraine

2. L. Khomenkova, X. Portier, J. Cardin, F. Gourbilleau. *Nanotechnology* **21**, 285707 (2010).

3. L. Khomenkova, B.S. Sahu, A. Slaoui, F. Gourbilleau, *Nanoscale research Letters* **6**, 172 (2011).

Hafnium-based dielectrics are promising high-k dielectrics to replace SiO₂ gate oxide in CMOS devices. However, in ultrathin film approach, the structure and the properties of these materials depend strongly on the deposition conditions and the post deposition treatment. It was predicted from the first principles that dielectric constant of hafnia can be significantly increased when this latter is doped by silicon and/or germanium¹.

We demonstrated recently that silicon plays the most important role to improve the thermal stability of ultrathin films at high temperature annealing and, thus, Si-doped hafnia can be successfully used for nanomemory applications^{2,3}. In this work, we will present the effect of germanium doping on the properties of hafnium-based dielectrics and compare with those observed for Si-doped hafnia.

The films investigated were fabricated by RF magnetron sputtering approach from HfO₂ target topped by either Si or Ge chips. The films were studied by means of XRD, TEM, FTIR and photoluminescence (PL) methods versus an annealing treatment. It was observed that Ge-doped films demonstrate phase separation at lower thermal treatment than their Si-doped counterparts. This phase separation occurs at 400-700°C and it is accompanied by the formation of Ge-nanoclusters and tetragonal HfO₂ phase. The stability of Si-doped films upon this annealing treatment was confirmed. Note that phase separation process for Si-doped hafnia starts from 1000°C.

The MOS capacitors were fabricated on the basis of HfO₂/HfGeO/HfO₂ and HfSiO/HfGeO/HfSiO stacks and their electrical properties were studied. The memory effect was observed in both types of MOS capacitors and the optimal annealing treatment was found to be at 600°C for 15 minutes. A memory window of ~7 V at a sweeping voltage of ± 14 V has been achieved.

The obtained results demonstrate that the RF magnetron sputtering is a promising technique for the production of different nonvolatile memory devices fully based on high-k dielectrics.

This work is supported by French National Agency (ANR) through Nanoscience, Nanotechnology Program (NOMAD Project n°ANR-07-NANO-022-02) and the Conseil Regional de Basse Normandie through CPER project - Nanoscience axe (2007-2013).

1. D. Fischer and A. Kersch, Appl. Phys. Lett. 92, 012908 (2008)