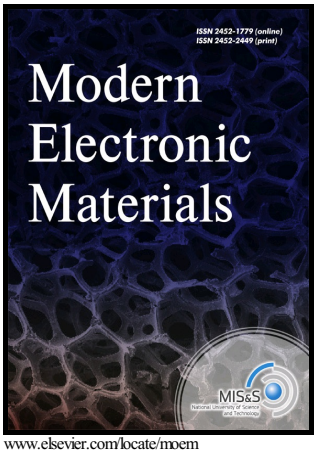

www.elsevier.com/locate/moem

Study of structure and surface morphology of two-layer contact Ti/Al metallization

Kirill D. Vanyukhin, Roman V. Zakharchenko, Nikolay I. Kargin, Mikhail V. Pashkov, Lev A. Seidman

PII: S2452-1779(16)30060-3
DOI: http://dx.doi.org/10.1016/j.moem.2016.09.005
Reference: MOEM33

To appear in: *Modern Electronic Materials*

Cite this article as: Kirill D. Vanyukhin, Roman V. Zakharchenko, Nikolay I. Kargin, Mikhail V. Pashkov and Lev A. Seidman, Study of structure and surface morphology of two-layer contact Ti/Al metallization, *Modern Electronic Materials,* http://dx.doi.org/10.1016/j.moem.2016.09.005

Study of structure and surface morphology of two-layer contact Ti/Al metallization

Kirill D. Vanyukhin[1], Roman V. Zakharchenko[1], Nikolay I. Kargin[1], Mikhail V. Pashkov[1], Lev A. Seidman[1]

[1]National Research Nuclear University MEPhI, Institute of Functional Nuclear Electronics,

31 Kashirskoe highway, Moscow 115409, Russia

K. D. Vanyukhin - author for correspondence - Engineer (kirivan@list.ru); R. V. Zakharchenko - Engineer; N. I. Kargin - Dr. Sci. (Eng.), Professor, Deputy Director IFNE (krgn@ya.ru); M. V. Pashkov - Postgraduate Student; L. A. Seidman - Cand. Sci. (Eng.), Senior Researcher, Head of Laboratory (seid1@yandex.ru)

Abstract. Ti/Al/Ni/Au metallization widely used in the technology of GaN base devices have a very important imperfection i.e. rough surface. There are different opinions about the causes of this imperfection: balling-up of molten aluminum or the appearance of intermetallic melt phases in the Au–Al system. To check the effect of the former cause, we have studied the formation of rough surface after annealing of Ti/Al metallization which is used as a basis of many metallization systems for GaN. The substrates were made from silicon wafers covered with Si_3N_4 films (0.15 microns). On these substrates we deposited the Ti(12 nm)/Al(135 nm) metallization system. After the deposition the substrates were annealed in nitrogen for 30 s at 850 °C. The as-annealed specimens were tested for metallization sheet resistivity, appearance and surface morphology. We have shown that during annealing of the Ti/Al metallization system, mutual diffusion of the metals and their active interaction with the formation of intermetallic phases occur. This makes the metallization system more resistant to subsequent annealing, oxidation and chemical etching. After annealing the surface of the Ti/Al metallization system becomes gently matted. However, large hemispherical convex areas (as in the Ti/Al/Ni/Au metallization system) do not form. Thus, the hypothesis on the balling-up of molten aluminum on the surface of the Ti/Al metallization system has not been confirmed.

Key words: ohmic contacts, contact metallizations, GaN, titanium-aluminum metallization, electron beam deposition method, thermal annealing of metallization.

Introduction

Most ohmic contacts to *n* conductivity type regions in AlGaN/GaN heterostructures are produced from multilayered metallization that usually contains two bottom Ti/Al metallic layers [1-8]. During annealing the ohmic contact to gallium nitride starts to form, and relatively high temperatures are required to complete this process, in the 800-900°C range [7]. As a result of annealing these two bottom metallization layers (Ti/Al) provide for low contact voltage due to their interaction with the semiconductor leading to the formation of thin TiN and Al–Ti–N nitride