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PII: S0997-7538(16)30240-6

DOI: 10.1016/j.euromechsol.2016.09.007

Reference: EJMSOL 3351

To appear in: *European Journal of Mechanics / A Solids*

Received Date: 12 May 2016

Revised Date: 5 August 2016

Accepted Date: 7 September 2016

Please cite this article as: Mishra, D., Pak, Y.E., Electroelastic fields for piezoelectric threading dislocation in various growth orientations of gallium nitride, *European Journal of Mechanics / A Solids* (2016), doi: 10.1016/j.euromechsol.2016.09.007.

Electroelastic Fields for Piezoelectric Threading Dislocation in Various Growth Orientations of Gallium Nitride †

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Abstract

Linear piezoelectric formulations were employed to analytically evaluate the electroelastic field generated by a single threading edge/screw dislocation in piezoelectric gallium nitride (GaN) thin film. All possible growth orientations, namely c-plane (polar), a- and m-planes (non-polar), and $(11\bar{2}2)$-plane (semi-polar) of GaN layers were considered for the analysis. Single piezoelectric threading edge and screw dislocations were also modeled by a commercial finite element analysis code, ABAQUS 6.14. The edge dislocation was modeled by invoking one-dimensional thermal strain analogy to effectively introduce an extra plane of atoms. The screw dislocation was modeled by creating a slip in opposite surfaces by applying opposite displacements of magnitude equal to half the Burgers vector parallel to the direction of dislocation line. We also evaluated the Peach-Kohler force acting on a piezoelectric dislocation as well as the material force calculated by the J-integral. The effects

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†This paper is dedicated to the late Prof. Seung-Hyun Yoo.