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Localized States and Charge Transfer at ZnO Surfaces and Interfaces[1]

LEONARD BRILLSON, The Ohio State University

With the advent of techniques to probe semiconductor electronic properties in the near-interface region on a nanometer scale, it is now possible to understand and control the mechanisms playing a role in localized state formation and charge transfer at ZnO interfaces. While world-wide research activity into this major new semiconductor has increased dramatically, the ability to control ZnO interfaces has been a major challenge to their opto- and microelectronic applications. Nanoscale depth-resolved cathodoluminescence and x-ray photoemission spectroscopies reveal the segregation of point defects and the donor character of hydrogen in the near-surface region. A conversion from ohmic to rectifying behavior is observed for gold contacts on atomically ordered polar ZnO surfaces following remote oxygen plasma treatment. This transition is accompanied by reduction of the well-known "green" deep level emission, suppression of the hydrogen donor-bound exciton photoluminescence and a large increase in n-type band bending. These results demonstrate that the contact type conversion involves more than one mechanism, specifically, removal of the adsorbate-induced accumulation layer plus lowered tunneling due to reduction of near-surface donor density and defect-assisted hopping transport. Schottky barriers for a wide array of metals on ZnO reveal that the strength of interface reaction plays a dominant role in forming near-interface defects and the resultant Schottky barriers. Similar correlations for other compound semiconductors indicate that the impact of near-interface native defects on Schottky barriers is more general in nature.

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[2] Y.M. Strzhemechny, H.L. Mosbacker, D.C. Look, D.C. Reynolds, C.W. Litton, N.Y.Garces, NC. Giles, L.E. Halliburton, S. Niki, and L.J. Brillson, "Remote Hydrogen Plasma Doping of Single Crystal ZnO," Appl. Phys. Lett. 84, 2545 (2004).

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