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Schottky characteristics dependency on the polarity of PEDOT:PSS/MgZnO interface

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I. Introduction

Recently, Schottky diodes on MgZnO have attracted considerable attention for the application in ultraviolet photodetectors and photovoltaic devices.[1,2] However, it has been difficult to achieve high quality Schottky using metal electrode, which encouraged to find alternative electrode such as polymer, (PEDOT:PSS).[3,4] We reported the Schottky contacts to MgZnO:N using metal and PEDOT:PSS electrodes, and the PEDOT:PSS is suitable electrode to nonpolar MgZnO:N with minimum dipole effect.[4] The present study demonstrates the details of the effect of interface polarity on Schottky characteristic of PEDOT:PSS/MgZnO.

II. Experiment

The polar {wurtzite (w-), rock salt (r-), mixed (w+r-)}, polar/nonpolar (w-), and nonpolar(w-) MgZnO films were grown on *a*- and *r*-sapphire substrates using RPE-MOCVD.[5,6] The Schottky diodes were fabricated using standard photolithography with Ohmic contact Ti/Au deposited by electron beam evaporation, and Schottky contact PEDOT:PSS deposited by spin coating.[4] The morphology and crystal structures were studied by SEM and XRD. The concentrations were measured by Hall-effect using van der Pauw configuration and current voltage (I-V) characteristics were performed after 5 min in dark using semiconductor parameter analyzer.

III. Results and discussion

Figure 1 shows the morphology and grain sketch of MgZnO films. The polar(w-) MgZnO was *c*-axis oriented with columns diameter 60 nm. The morphology becomes flat for polar(w+r-) MgZnO film and smooth surface for rock salt MgZnO. The polar/nonpolar(w-) MgZnO was both *c*- and *a*-axis oriented with columns (100 nm) and sheets (220 nm), while nonpolar(w-) film was *a*-axis oriented with sheets 320 nm. The concentration of polar(w-), polar/nonpolar(w-), and nonpolar(w-) MgZnO films are ~10^{17}, 10^{18}, and 10^{18}cm^{-3}, respectively. The concentration of w+r- and r-MgZnO films are not known due to the limitation of Hall set up.

Figure 2 shows the J-V curves of PEDOT:PSS/MgZnO Schottky contacts, in which the rectifying characteristics depend strongly on polarity of the films. The rectification ratio of order 5 was observed for w+r-MgZnO. The higher current density of 2×10^{-3} A/cm^2 at -3V for polar(w-) MgZnO is due to the high leakage current associated with columnar grains. The rock salt MgZnO with smooth surface showed lowest current density 1×10^{-8} A/cm^2 at -3V *i.e.* low leakage current. The minimum current at -Ve voltage for all diodes for sweep -3V to +3V was due to the formation of built-in dipole at the interface, in accordance with Bardeen model,[1] The nonpolar(w-) MgZnO showed minimum dipole effect and improved rectifying characteristics.[4] The minimum current was at +Ve voltage for sweep +3V to -3V, and indicated the persistent photo-conductivity (PCC) effects.[2] Therefore, the nonpolar and smooth interface of MgZnO films is vital for good rectification characteristics of Schottky diodes.

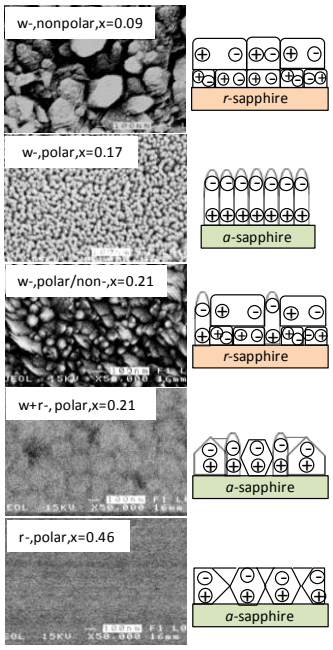

Fig.1. SEM images and grain sketch.

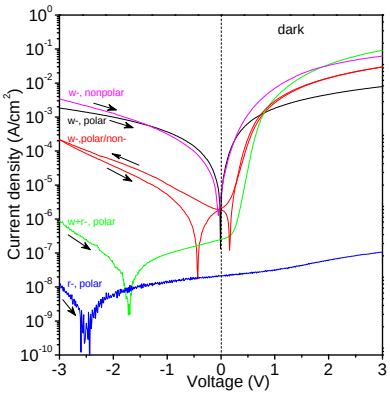

Fig. 2. J-V curves of Schottky diodes.

IV. References

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