SEMICONDUCTING OXIDE THIN FILMS: NOVEL RECTIFYING CONTACTS FOR ELECTRONIC AND PHOTONIC APPLICATIONS

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We present a number of novel rectifying material combinations (thin film heterostructure diodes) involving semiconducting oxides that provide excellent rectification [1]. We discuss the interfaces and the physical mechanisms of rectification, device properties and the possible use in applications. Three diodes are discussed in some detail: n-ZnO/p-NiO, n-ZnO/p-ZCO and n-ZnO/p-CuI.

n-ZnO/p-NiO forms a type-II heterostructure due to the conduction band lineup. Optimized structures exhibit high rectification and exhibit photovoltaic energy conversion combined with high transparency in the visible range ("transparent solar cell"). Only the UV part of the spectrum is converted with an efficiency of 3-4% [2,3]. The heterojunction can also serve as gate in transparent junction field effect transistors (JFET) [4].

n-ZnO/p-ZCO involves a p-type electrode made from amorphous zinc cobalt oxide which is fairly insulating as epitaxial $ZnCo_2O_4$ thin film. In 2014 the high rectification of such diode has been reported for the first time [5]. In the meantime we have reported JFET inverters [6] and JFET ring oscillators (Fig. 1) [7] based on such gate diodes.

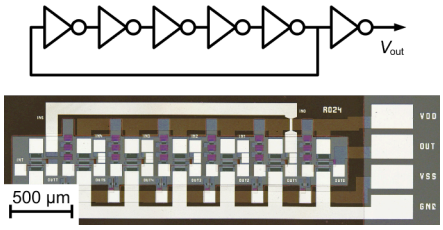

Fig. 1. Schematic and optical image of ZnO JFET-based ring oscillator (ZnO/ZCO gate diodes)

CuI was the first transparent material ever reported (1907) [8] and forms together with n-ZnO highly rectifying diodes [9]. The role of the interface in this type-II heterostructure diode is theoretically modeled and analyzed.

Keywords: diodes; oxide semiconductors; JFET; rectification; interface; transparent electronics

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