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Ion irradiation on ZnO and other metal oxides: prospects, challenges and future directions

ZnO is a well-known wide band gap (3.37 eV at room temperature), intrinsically n type and extremely radiation hard semiconductor [1]. The exciton binding energy of ZnO is ~ 60 meV. Intense luminescence in the ultra-violet region due to exciton recombination is seen from ZnO at room temperature [2]. Hole doping in ZnO (p type) is challenging, still there are reports [1]. Furthermore, undoped ZnO is diamagnetic but becomes ferromagnetic due to intrinsic or extrinsic defects. In brief, ZnO is a promising candidate for opto-electronic devices, particularly useful in high radiation environments as in spacecrafts.

On this regard, ion irradiation in ZnO is extremely important from several considerations. Defect accumulation in ZnO due to energetic particles is intensely investigated [3,4]. In fact, choice of ion, its energy, fluence, irradiation conditions etc. is important to achieve a purposeful defective/doped state of ZnO. Ion irradiation with suitable ions is beneficial to fabricate p type or ferromagnetic ZnO. Tuning of ZnO resistance up to 10 orders of magnitude can be done using ion irradiation. Knowledge on semiconductor-metal junction properties is necessary for ZnO based devices and irradiation technique has been found to be fruitful to tailor such junction properties.

Defect probing in ZnO is another interesting area of study. Positron annihilation, Raman, photoluminescence, Rutherford backscattering spectroscopy, several microscopic techniques and synchrotron based spectroscopic probes have been employed. Rich defect physics and chemistry of ZnO have been unearthed and yet to be explored fully.

Summary of our works based on H, C, N, O and Ar ion irradiations on ZnO will be discussed in the direction for strategic investigation on other metal oxides. Irradiation with few stable and radio-isotopic beams on ZnO and their possible applications will also be mentioned.

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