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The Status of p-type ZnO

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In recent years, ZnO has been proposed as an ideal material for new electronic and optoelectronic devices, such as transparent transistors and UV light-emitting diodes (LEDs). However, the LED application will require both n-type and p-type ZnO and the latter is difficult to produce. Potential acceptors include Group V and Group I elements, substituting for O and Zn, respectively. Unfortunately, the Group I elements (e.g., Li) tend to produce semi-insulating material, because they can, in some cases, enter the lattice either as acceptors or donors. On the other hand, the Group V elements, N, P, and As, have all proven to be viable acceptor dopants. Interestingly, theory predicts that P_O and As_O should be *deep* acceptors, and not highly soluble in ZnO. Thus, it has been proposed that the As acceptor is not As_O, but rather As_{Zn}-$2V_{Zn}$, which should be more soluble and also should have a lower transition energy. Compensating donors must also be minimized, and the most prominent of these are Al_{Zn}, interstitial H, and possibly interstitial-Zn complexes. Some ZnO homojunction p-n UV LEDs have already been produced, but more success has been achieved with heterojunction LEDs, using AlGaN as the hole injector. Future prospects will be discussed.