Practical doping principles

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with killer defects, or prevent E_F from moving.'' An example is the use of H during Mg doping[12] of GaN: without H, excessive *p*-type Mg doping will lead to the spontaneous formation of V_N once the Fermi energy moves sufficiently towards the VBM. But since H acts as a donor, it prevents the movement of E_F towards the VBM, thus defeats the formation of the V_N killer defect. Subsequently, H is annealed out. This rule suggests, for example, that *p*-type doping of oxides can be facilitated by creating internal oxygen precipitates that eliminate oxygen vacancies, e.g., using NO or NO_2 sources[3,5] for nitrogen-doping of ZnO, or using Li_2O sources for Li doping of MgO (Ref. 23).

(ii) *Doping rules pertaining to chemical potential effects.* In general, the second term of Eq. (1) shows how ΔH for formation of anionic or cationic dopants can be regulated via control of the chemical potentials during growth [Fig. 1(b)]. This figure illustrates the fact that the enthalpy of forming