We propose the local density approximation (LDA) plus an on-site Coulomb self-interaction-like correction (SIC) potential for describing sp-hybridized bonds in semiconductors and insulators. We motivate the present LDA+USIC scheme by comparing the exact exchange (EXX) hole with the LDA exchange hole. The LDA+USIC method yields good band-gap energies $E_g$ and dielectric constants $\varepsilon(\omega=0)$ of Si, Ge, GaAs, and ZnSe. We also show that LDA consistently underestimates the G-point effective electron $m_e$ and light-hole $m_{lh}$ masses, and the underlying reason for this is a too strong light-hole electron coupling within LDA. The advantages of the LDA+USIC approach are a computational time of the same order as the ordinary LDA, the orbital dependent LDA+USIC exchange-correlation interaction is asymmetric analogously to the EXX potential, and the method can be used for materials and compounds involving localized $d$- and $f$-orbitals.

Keywords

Electronic structure; Optical properties; LDA+USIC