Recent theoretical and experimental studies on the third-order optical nonlinearities of higher fullerenes including $C_{70}$, $C_{76}$, $C_{84}$, $C_{86}$, $C_{90}$, $C_{94}$ and $C_{96}$ are briefly reviewed. The extended Su-Schrieffer-Heeger model is introduced and applied to study the third-order optical nonlinearity of chiral carbon nanotubes (CCN), where the average contribution $\Gamma$ of one carbon atom to the third-order optical nonlinearity of each CCN is calculated and compared with that of a well characterized polyenic polymer. It is found that (i) the smaller the diameter of a CCN, the larger the average contribution $\Gamma$; (ii) the metallic CCN favors larger third-order optical nonlinearity than the semiconducting one; (iii) CCN can compete with the conducting polymer achieving a large third-order optical susceptibility. Also the doping effect on the second-order hyperpolarizability of a tubular fullerene is investigated. It is found that the doping effect increases greatly the magnitude of the second-order hyperpolarizability of tubular fullerene.

**Key words:** Optical Susceptibility; Hyperpolarizability; Sum-over-state Approach; Resonance Enhancement; $C_{60}$; Higher Fullerene; Tubular Fullerene; Carbon Nanotube; Chiral Effect; Doping Effect.