Variable range hopping kinetics in CdSe optoelectronic switches under photonic excitations

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Abstract

New type of memory switch that can be controlled via photonic excitations is invented and characterized. The optoelectronic switching cell is made of the photovoltaic n-type CdSe thin films. The films which were prepared by the physical vapor deposition technique onto chemically cleaned glass substrates at a vacuum pressure of ~10^{-6} mbar are characterized by means of temperature dependent electrical conductivity at various illumination intensities. In addition to the thermionic emission, the current transport mechanism of these thin layers are observed to be dominated by the variable range hopping of charged particles through the potentials created mostly at the randomly distributed grains and relative boundaries. The variable range hopping parameters presented by the degree of disorder (T_o), the density of localized states near the Fermi level ($N(E_F)$), the average hopping range (R) and average hopping energy (W) are observed to be highly sensitive to the photonic excitations. Particularly, the average hopping energy and the average hopping range were decreased significantly. On the other hand, the density of localized states near the Fermi level increased when the light intensity was increased. Such behavior is attributed to the temporary shift in Fermi level and/or trap density reduction by electron-hole recombination. Such type of localized density and hopping range attenuations are promising as they indicate better performance of memory switches under photonic excitations. In other words, the ability of data storage, the data recall, the power consumption and the response time are highly improved via photo-hopping control.