Abstract

In this issue of *Defect and Diffusion Forum* we report our investigation on the effects of finite temperatures on weakly disordered hydrogenated amorphous silicon (a-Si:H) and hydrogenated amorphous germanium (a-Ge:H). We have also investigated the effect of weak disorder on more complex systems such as GaAs and its alloy $Al_xGa_{1-x}As$.

For the elemental amorphous systems, we reconsider a previous self-consistent treatment of localization on a Cayley tree for weak disorder described by a Cauchy-Lorentzian distribution of site energies. The treatment is generalized to a system with n electronic states at each site and is an extension of the usually considered model for disordered systems. The effect of the electron–phonon interaction on the site energy distribution is consistently taken into account, not only in the distribution of the self-energy but also in that of the derivative of the self-energy, which determines the mobility edge, E_c. This important improvement leads to a temperature dependent E_c which reduces to well known results in the zero temperature and zero disorder limits. The mobility gap and its temperature coefficient determined from these calculations are compared with optical gap data obtained from isoabsorption, photoluminescence, and optical transmission measurements on hydrogenated amorphous silicon and germanium. We find very good agreement over a wide temperature range with a judicious choice of physical parameters in the model.

We have further studied the effects of disorder induced band tailing on deep levels in compound semiconductor alloys, such as GaAs and $Al_xGa_{1-x}As$. In particular, we have eliminated the assumption of Gaussian broadening of the defect density of states proposed earlier by others on the basis of the central limit theorem. The expressions derived for the capacitance transients in the presence of the disorder induced band tailing are quite different from previously published results and indicate that the form of the broadening function is quite sensitive to, and should closely reflect, the underlying physical environment. We applied this theory to the investigation of the deep level transient spectra (DLTS) in GaAs and $Al_xGa_{1-x}As$. Our results indicate that standard experimental measurements of DLTS, without appropriate corrections, in general, can underestimate the activation energy, capture cross-section, etc., even in the case of weak disorder.

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