produced by a spatially intimated coupling of pairs between dangling bonds and positively ionized impurities.

6-5. Summary

(1) The steady-state and transient HMC methods have been applied to determining densities and profiles of midgap states in undoped a-$Si_{1-x}Ge_x$:H, undoped a-Si:H and undoped a-$Si_{1-x}C_x$:H. The midgap states are correlated with D^0; the density in a-$Si_{1-x}Ge_x$:H ($E_0 \leqq 1.63$ eV) represents the D^0 density of Ge, and in a-Si:H and a-$Si_{1-x}C_x$:H ($E_0 \leqq 1.88$ eV) it represents the D^0 density of Si. The density of midgap states increases slowly with the Ge content in the film, while it increases rapidly with the C content. The peak of the midgap-state profile appears clearly in a-Si:H and a-$Si_{1-x}Ge_x$:H, but it does not appear clearly in a-$Si_{1-x}C_x$:H.

(2) Thermal annealing kinetics of metastable gap states in short-time light-soaked a-Si:H have been investigated. Monomolecular kinetics are suitable for explaining the experimental data. The thermal activation energy (E_a) for annealing decreases monotonously with an increase in (E_C-E). This is the first report which elucidates the relation between E_a and (E_C-E).

(3) The midgap states having a small ν_n are created both optically and thermally, while the midgap states having a large ν_n are created only by light soaking. Both states are located around 0.85 eV below the conduction band edge.