below the Fermi level in highly resistive amorphous films can be determined from the experimental results involving measurements of transient capacitance as well as its temperature-dependence of those heterojunctions.

5-2. Transient Capacitance

Figure 5.1 shows the change in the capacitance after a reverse-bias voltage (-4 V) is applied to an undoped a-Si:H/p c-Si (N_A=1.0x10^{16} cm^{-3}) heterojunction which was under the zero-bias condition for a certain time. In almost of the whole a-Si:H, the gap states between E_F and E_{0B} are full of electrons under the zero-bias condition. After applying the reverse-bias voltage, the electrons trapped at the gap states between E_F and E_{0B} are going to be re-emitted to the conduction band, which results in the change of the positive space-charge density in the depletion region of undoped a-Si:H. Because a-Si:H possesses deep gap states whose emission rates are small, the capacitance gradually decreases with time (t). Since the steady-state HMC method has made it possible to get the midgap-state density, this transient HMC must include information on the g(E) of the midgap states. From the transient behavior of the capacitance, the g(E) in undoped a-Si:H can be determined as discussed in the following sections. This method is a powerful technique for determining the g(E) below the Fermi level in undoped a-Si:H because it has been difficult to obtain the g(E) in such a highly resistive semiconductor by the conventional transient capacitance methods, such as deep-level transient spectroscopy (DLTS)[1] and isothermal capacitance transient spectroscopy (ICTS)[2] using Schottky barrier diodes and homogeneous p-n diodes, as mentioned in Chapter I .

5-3. Theory of Transient HMC Method

In order to estimate the g(E) below the Fermi level, the

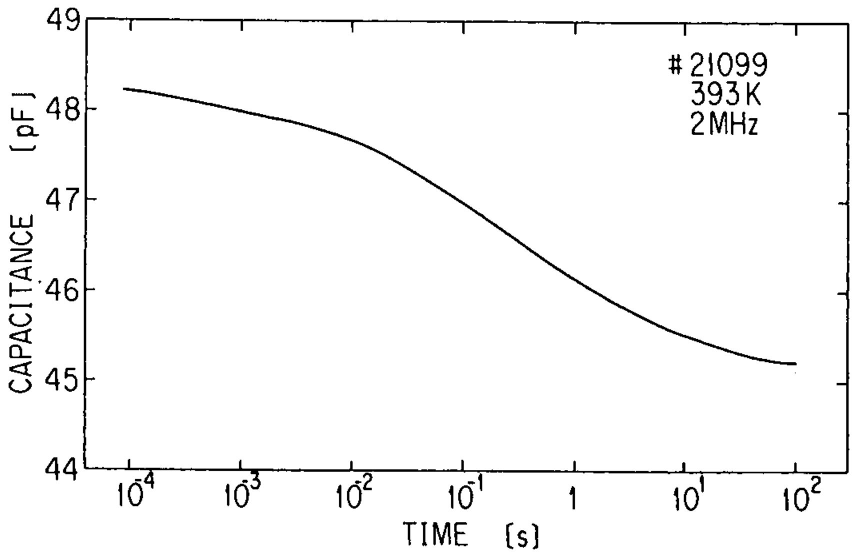

Fig.5.1. Transient capacitance of undoped a-Si:H/p c-Si (N_A=1.0x10^{16} cm^{-3}) heterojunction.