CHAPTER Ⅳ CURRENT-VOLTAGE CHARACTERISTICS OF UNDOPED a-Si:H/p c-Si HETEROJUNCTIONS

4-1. Introduction

There are very few reports concerning amorphous/crystalline semiconductor heterojunctions after the first report of Grigorovici et al.[1] on amorphous germanium (a-Ge)/crystalline germanium (c-Ge) heterojunctions. Those a-Ge films had such a lot of gap states that p-n control in the films could not be made. According to Stourac,[2] for the case of chalcogenide materials as an amorphous material, the current-transport mechanism was based on space-charge-limited currents (SCLC) in the chalcogenide materials. Concerning hydrogenated amorphous silicon (a-Si:H)/crystalline semiconductor heterojunctions, almost no data had been published before this study started, where a-Si:H has been attractive for device applications because p-n control in a-Si:H has succeeded.[3]

This chapter presents a systematic study of undoped (i.e., slightly n-type) a-Si:H/p-type crystalline silicon (p c-Si) heterojunctions for the first time. The purpose in this chapter is to elucidate the current-transport mechanism of those heterojunctions.

4-2. I-V Characteristics

Figure 4.1 shows the typical I-V characteristics in (a) log-log and (b) semilog presentations for an undoped a-Si:H/p c-Si heterojunction with an acceptor density (N_A) in p c-Si of 1.0×10^{16} cm^{-3}. Two sorts of current-transport mechanisms have been proposed to explain these I-V characteristics;

(1) a bulk-limited (space-charge-limited) current-transport mechanism,[4]

(2) a junction-limited current-transport mechanism.[5]

The essential difference between (1) and (2) is whether the