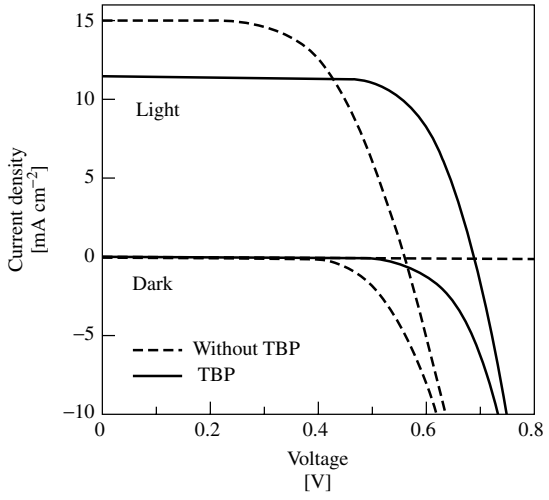

Figure 15.10 Current–voltage characteristics of N3 dye-sensitized TiO_2 solar cells under illumination and darkness using electrolyte with and without TBP: (— —) without TBP, (——) with TBP

Dark current is considered to occur at the TiO_2/electrolyte interface where the photosensitizers are not adsorbed. To suppress dark current, pyridine derivatives such as *tert*-butylpyridine (TBP) have been employed as coadsorbates on the TiO_2 surface, resulting in the improvement of photovoltage [6, 52]. TBP is considered to adsorb on the uncovered TiO_2 surface. Figure 15.10 shows the current–voltage characteristics of the N3 dye-sensitized TiO_2 solar cell under illumination and darkness, using electrolyte with and without TBP. This clearly indicates that TBP suppresses dark current, resulting in the improvement of V_{OC}. A decrease of the J_{SC} by addition of TBP is considered to be due to the negative shift of the conduction-band level of TiO_2 owing to adsorption of TBP, which has basic property, leading to suppression of the electron injection from the dye.

The kinetics of recombination, reaction [5], has been investigated and discussed [6, 52, 54–59]. If this reaction occurs predominantly with a large reaction rate, the DSSC does not work. Taking into consideration this and the slow transport of the photoinjected electrons through the nanocrystalline TiO_2 film (described in the next section), the recombination must be extremely slow. In fact, the rate of recombination has been estimated to be on the order of 0.1 s to several seconds [56]. This slow recombination would be due to a low electrocatalytic activity of TiO_2 for the reduction of tri-iodide ions.

15.1.4.5 Electron transport in TiO_2 film

Electron transport in TiO_2 film is an important process related to PV performance in the DSSC (see Figure 15.9) and has been studied by many researchers [60–74]. The electron transport in nanocrystalline TiO_2 film has been discussed with respect to different mechanisms: a diffusion model [60–63], a mechanism that involves tunneling through potential barriers between the particles [63], a trapping/detrapping mechanism [65–68], and an insulator–metal (Mott) transition mechanism [69]. Electron conductivity in TiO_2 is very small, resulting in slow response of the photocurrent. For example, diffusion