Preface

Photovoltaics, converting light to electricity, are one of most promising alternatives to fossil fuels. Since the discovery of photovoltaic effect from selenium by 19-year-old Edmund Becquerel in 1839, several kinds of photovoltaic materials have been discovered and their photovoltaic performances have been studied. Silicon started with power conversion efficiency (PCE) of 4.5 % in 1954, developed by Bell Labs researchers Pearson, Chapin, and Fuller, which has now surpassed 25 %. To date, the best PCE was found from GaAs, approaching 29 % with single junction structure. Chalcogenide materials such as CIGS and CdTe exhibited promising PCEs of about 22 %. In developing solar cells, materials and processing costs are as important as PCE. This means that new photovoltaic materials being able to produce low-cost electricity are of crucial importance to both academy and industry.

Organic–inorganic halide perovskite is very promising candidate for future photovoltaic society because its PCE now reached over 22 % that can be available from inexpensive and high-throughput solution process. Halide perovskite photovoltaics were introduced in 2009 by Tsutomu Miyasaka and the currently studied solid-state perovskite solar cells are based on the invention of solid-state perovskite-sensitized solar cell in 2012 by Nam-Gyu Park and Michael Grätzel. However, the origin of superb photovoltaic performance is still questionable. Structural diversity is advantage in perovskite photovoltaics, but it is still arguable which device structure is suitable for less I–V hysteresis and long-term stability. Understanding fundamentals and device architectures may lead to answers to these questions, which motivated us to write this book. In Chaps. 1 and 2, fundamentals of halide perovskites are described based on theoretical point of view. Maximum efficiency can be expected from Chap. 3. Device physics and ion migration behavior in halide perovskite are understood in Chaps. 4 through 6. More understanding on charge transport and inhibition will be expected from Chaps. 7 and 8. In Chap. 9, device and materials engineering are described to achieve high-efficiency perovskite solar cells. I–V hysteresis and stability issues will be treated in Chap. 10. Perovskite solar cell is promising resource for hydrogen evolution due to high-voltage characteristics, which is described in Chap. 11. Perovskite is excellent light absorber even in organic bulk heterojunction-type solar cell, which is presented in Chap. 12. Intrinsic flexibility is one of strong points in halide perovskite, which is suitable for flexible solar cell as can be found in Chap. 13. Selective contact materials are issued in terms of hysteresis and stability. Inorganic hole transporting layers may provide insight into device engineering, which is described in Chap. 14. Since this book covers from fundamentals to device engineering, we hope that this book contributes to both academy and industry.

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