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Photo-Excited Charge Collection Spectroscopy

Probing the Traps in Field-Effect Transistors

Springer

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To the Lord Jesus and my wife Jihye

Seongil Im, 2013–01–10

Preface

Solid-state field-effect devices such as organic and inorganic-channel thin-film transistors (TFTs) have been expected to promote advances in display electronics based on low cost, high transparency, and flexibility. The operational stabilities of such TFTs are thus important, strongly depending on the nature and density of charge traps present at the channel/dielectric interface or in the thin-film channel itself. In particular, the illuminated display back panel is susceptible to the charge-trap-induced instability. As conventional tests for the device instabilities, gate-bias stress techniques are adopted in general, however, those appear limited in providing any satisfying information.

This book contains how to characterize these traps, starting from the device physics of field-effect transistor (FET). Unlike conventional analysis techniques which are away from well-resolving spectral results, newly introduced photo-excited charge-collection spectroscopy (PECCS) utilizes the photo-induced threshold voltage (V_{th}) response from any type of working transistor devices with organic-, inorganic-, and even nanochannels, directly probing on the traps. So, our technique PECCS has been discussed through more than ten refereed-journal papers in the fields of device electronics, applied physics, applied chemistry, nanodevices, and materials science, finally finding a need to be summarized with several chapters in a short book. In this book, Chap. 1 addresses the device physics of FET and the main principles of PECCS measurements, of which the detailed instrumentations are introduced in Chap. 2. From Chaps. 3 to 5 we address the applications of PECCS on organic, oxide, and nanostructure-based FETs while in the last Chap. 6 we discuss some weakness of PECCS and summarize the whole chapters as well. In the book, we distinguished the term TFT from FET, which may be a more extensive term including TFT, since we treated both thin-films and nanowires/or nanosheets for transistor fabrications and measurements.

Besides the coauthors, I acknowledge Dr. Kimoon Lee, presently at Tokyo Institute of Technology for his innovative initiations on PECCS, my graduate student Syed Raza Ali for the PECCS characterizations on ZnO nanowire-based field-effect transistors, Dr. Do Kyung Hwang, Dr. Ji Hoon Park, and Dr. Jiyoul Lee for the supports with their organic field-effect transistors, Dr. Jeong-Min Choi in Korean Intellectual Property Office for Patent examining.

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