Thin Film Transistor Circuits and Systems

Providing a reliable and consolidated treatment of the principles behind large-area electronics, this book contains a comprehensive review of the design challenges associated with building circuits and systems from thin film transistors.

The authors describe the architecture, fabrication, and design considerations for the principal types of TFT, and their numerous applications. The practicalities of device non-ideality are also addressed, as are the specific design considerations necessitated by instabilities and non-uniformities in existing fabrication technologies.

Containing device-circuit information, discussion of electronic solutions that compensate for material deficiencies, and design methodologies applicable to a wide variety of organic and inorganic disordered materials, this is an essential reference for all researchers and circuit and device engineers working on large-area electronics.

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"The book is an absolute must for everyone seriously interested in pixel circuits for active matrix organic light-emitting displays and flat panel imagers."

Norbert Fruehauf, University of Stuttgart

"Various TFT materials and devices have been developed for addressing liquid crystal displays and organic light-emitting diode displays. Lately, high mobility oxide semiconductors are emerging, which promises higher resolution and larger aperture ratio for improving optical efficiency. There is an urgent need for such a book to give a systematic approach to basic material properties, advanced circuit designs, and integrated operation systems for this $100B display industry. The authors are respected experts in the field. I wish to have this book on my desk soon."

Shin-Tson Wu, University of Central Florida

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Frontmatter
More information

Contents

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Preface

Advances in thin film materials and process technologies continue to fuel new areas of application in large area electronics. However, this does not come without new issues related to device-circuit stability and uniformity over large areas, placing an even greater need for new driving algorithms, biasing techniques, and fully compensated circuit architectures. Indeed, each application is unique and mandates specific circuit and system design techniques to deal with materials and process deficiencies. As this branch of electronics continues to evolve, the need for a consolidated source of design methodologies has become even more compelling. Unlike classical circuit design approaches where trends are toward transistor scaling and high integration densities, the move in large-area electronics is toward increased functionality, in which device sizes are not a serious limitation. This book is written to address these challenges and provide system-level solutions to electronically compensate for these deficiencies.

Although the circuit and system implementation examples given are based primarily on amorphous silicon technology, the design techniques and solutions described are unique, and applicable to a wide variety of disordered materials, ranging from polysilicon and metal oxides to organic families. These are complemented by real-world examples related to active-matrix organic light emitting diode displays, bio-array sensors, and flat-panel biomedical imagers. We address mixed-phase thin film and crystalline silicon electronics and, in particular, the design and interface techniques for high and low voltage circuits in the respective design spaces. The content is concise but diverse, starting with an introduction to displays, flat panel imagers, and associated backplane technologies, followed by design specifications and considerations addressing compensation and driving schemes. Here we introduce hybrid voltage-current programming, enhanced-settling current programming, and charge-based driving schemes for high-resolution pixelated architectures.

Apart from designers of imaging and display systems and the engineering community at large, this book will benefit material scientists, physicists, and chemists working on new materials for thin film transistors and sensors. It can serve as a text or reference for senior undergraduate and graduate courses in electrical engineering, physics, chemistry, or materials science. Much of the material in the book can be presented in about 30 hours of lecture time.

This book would not have been possible without the support of the Giga-to-Nano Labs at the University of Waterloo; Ignis Innovation Inc. in Waterloo; the London Centre for Nanotechnology, University College London; and the Centre for Large Area Electronics, University of Cambridge. We acknowledge the financial support provided by the Natural Sciences and Engineering Research Council, Canada, the Communications and Information Technology Ontario, Canada, and the Royal Society Wolfson Merit Award, UK.

Reza Chaji and Arokia Nathan
Waterloo and Cambridge, 2013