

Preface

The origins of the organic-based solid-state lighting (SSL) date back to 1953, but it was only in the 90s when the organic-based light-emitting diode (OLED) and light-emitting electrochemical cell (LEC) technologies started to flourish. Although OLEDs have made all the way from laboratory to commercial products, the LEC technology is considered as the simplest SSL device. The two pillars of LECs are the type of emitter that holds charge injection, charge transport, and emission and the ionic additive that assists charge injection at low applied voltages. As introduced by Prof. Pei in the foreword, the LEC revolution is based on the use of ions to reduce the turn-on voltage. After 15 years of research, we have gained a mature understanding of the device mechanism. This has, in addition, been achieved along with the optimization of the two traditional emitters (luminescent conjugated polymers and ionic transition metal complexes), the ionic additives for each type of emitters, and the type of poling modes. After having fully understood the device limitations, we have achieved several breakthroughs with respect to the efficiency using multilayered architectures (cascade and/or tandem), frozen junctions, color converting layers, etc. and low-cost and up-scalable fabrication protocols using, in addition, unconventional conductive substrates. As the most recent research action, we have focused on investigating different types of emitters like small molecules, nanoparticles, quantum dots, etc. Hence, the last two decades have been a successful test-bed time for LECs, reaching both a high industrial relevance and an always-rising research interests, as LECs are an easy set-up to investigate the electroluminescence features of the emitters and the device physics of ionic-based optoelectronics.

Overall, I felt that it was now the right time to bring together all the efforts of the LEC community in this first book devoted to the LEC technology. The intention of this book is to provide to young students a general description of the LEC technology with a focus on the device mechanism and the different techniques to elucidate the role of mobile anions (Part I). After this general view, they will enjoy two sections specialized on the definition and role of the ionic additives (Part II), as well as the last advances in traditional and new electroluminescent materials (Part III). Part II is divided into five chapters that describe in-depth the type of ionic

additives and the different techniques to study the effect of the mobile ions on the device mechanism (Chaps. 2 to 5), as well as how the ionic electrolytes are crucial for the fabrication of LECs using deposition tools of industrial relevance (Chap. 6). Part III consists of seven chapters summarizing i) the progress in designing iridium(III) complexes (Chap. 7), in general, and blue-emitting iridium(III) complexes (Chap. 8), in particular, ii) the studies on new materials with thermally activated delayed fluorescence features (Chap. 9) as well as exciplex emission in conjugated polymers (Chap. 10), and iii) the last advances in new electroluminescent materials, such as copper(I) complexes (Chap. 11), small-molecules (Chap. 12), and quantum dots (Chap. 13).

My intention is to provide a comprehensive vision of the past and present developments in the LEC technology as insights for future advances covering new device designs, industrial progress, and novel types of emitters.

Erlangen, Germany

Rubén D. Costa

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