

Preface

Solid state lighting (SSL) is recognized as the second revolution in the history of lighting. The primary reason is the annual global energy bill saving of €300 billion and a reduction of 1,000 MT of CO₂ emission. As such, the SSL industry is expected to exceed €80 billion by 2020, which will in turn create new employment opportunities and revenues. A second reason is the promise of a long useful lifetime, with claims up to 80,000 h. As with any products, the consistency and reliability of SSL systems need to be ensured before they can be adopted in any applications. To add to the complexity, there is also a need to ensure that the cost of this technology needs to be comparable or even lower than the current technology. Although SSL systems with low reliability requirements have already been developed, they can only be used in applications that operate in modest environments or in noncritical applications. For demanding applications in terms of environmental conditions, such as automotive application, or where strict consistency is needed, such as healthcare applications and horticulture applications, the conventional lighting sources are currently still preferred until the reliability of SSL is proven in these applications. Therefore, the knowledge of reliability is crucial for the business success of SSL, but it is also a very scientific challenge. In principle, all components (LEDs, optics, drive electronics, controls, and thermal design) as well as the integrated system must live equally long and be highly efficient in order to fully utilize the product lifetime, compete with conventional light sources, and save energy.

It is currently not possible to qualify the SSL lifetime (10 years and beyond) before these products are available in the commercial market. This is a rather new challenge, since typical consumer electronics devices are expected to function for only 2–3 years. Predicting the reliability of traditional electronics devices is already very challenging due to their multidisciplinary issues, as well as their strong dependence on materials, design, manufacturing, and application. Predicting SSL reliability will be even more challenging since they are comprised of several levels and length scales of different failure modes. The tendency towards system integration, via advanced luminaries, System-in-Package approaches, and even heterogeneous 3D integrations poses an additional challenge on SSL reliability.

A functional SSL system comprises different functional subsystems working in close collaboration. These subsystems include the optics, drive electronics, controls, and thermal design. Hence, there is also a need to address the interaction between the different subsystems. Furthermore, an added challenge for system reliability is that accelerated testing condition for one subsystem is often too harsh for another subsystem. Alternatively, even the highest acceleration rate possible for one subsystem may be too low to be of any use for yet another subsystem. Hence, new techniques and methodologies are needed to accurately predict the system-level reliability of SSL systems. This would require advanced reliability testing methods, since today's available standards are mainly providing the probability at which LEDs may fail within a certain amount of time.

Today, no open literature that covers the reliability aspects for SSL exists, ranging from the Light Emitting Diode (LED) to the total luminaire of a system of luminaires. This book will provide the state-of-the-art knowledge and information on the reliability of SSL systems. It aims to be a reference book for SSL reliability from the performance of the (sub-) components to the total system. The reliability of LEDs and all other components (optics, drive electronics, controls, and thermal design) as well as the integrated system of an SSL luminaire will be covered. Various failure modes in SSL luminaire will be discussed. Different reliability testing and luminaire reliability testing performance will be introduced. The content has an optimal balance between theoretical knowledge and industrial applications, written by the leading experts with both profound theoretical achievement and rich industrial experience. Parts of the contents are firsthand results from research and development projects.

This book is part of a series on Solid State Lighting, edited by Prof. G.Q. Zhang. The series will systematically cover all key issues of solid state lighting technologies and applications.

Eindhoven, The Netherlands
Beaumont, TX, USA

W.D. van Driel
X.J. Fan

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Components to Systems

van Driel, W.D.; Fan, X. (Eds.)

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