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Fabrication and characterization of electroluminescent devices based on metal chalcogenides and halide perovskites

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Fabrication and characterization of electroluminescent devices based on metal chalcogenides and halide perovskites

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 groningen

faculty of science
 and engineering

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 advanced materials

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UNIVERSIDAD NACIONAL AUTÓNOMA DE MEXICO
POSGRADO EN CIENCIA E INGENIERÍA DE MATERIALES
INSTITUTO DE INVESTIGACIONES EN MATERIALES
ZERNIKE INSTITUTE FOR ADVANCED MATERIALS

**FABRICATION AND CHARACTERIZATION OF ELECTROLUMINESCENT
DEVICES BASED ON METAL CHALCOGENIDES AND HALIDE
PEROVSKITES**

TESIS
QUE PARA OPTAR POR EL GRADO DE:
DOCTORA EN CIENCIAS EN INGENIERÍA DE MATERIALES

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CIUDAD DE MEXICO AGOSTO 2021

*To my parents,
for their endless love and support*

In memory of my grandmother

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Motivation & Objectives

Displays full of rich and vibrant colors are acquired conveniences in modern times where devices as smartphones, tablets, and TVs have become indispensable for our daily routine. At the same time, efficient artificial lights reshaped the illumination design indoors and outdoors. However, for these technologies to be settled as commercially available products, they had to fulfill standardized requirements. This demanded significant time of research to address the multiple challenges associated with the development of such technologies. For instance, punctual white-emitting sources became accessible thanks to the invention of an efficient blue component, which required more than three decades in development. This invention was so relevant that it was awarded a Nobel prize in Physics in 2014. Nowadays, the scientific community is moving towards the so-called next generation of solid-state light emitters for displays and illumination. The next generation is seeking efficient semiconductors, especially for large-area applications, at lower manufacturing costs. Presently, the technologies comprising organic-based and quantum confined materials are achieving promising results for large-area self-emissive displays and white-light emitters. Nonetheless, one of the major obstacles is to reach an efficient blue-emitting semiconductor feasible for the aforementioned applications. Therefore, extensive investigations are being carried out to find potential semiconductors able to meet the standardized requirements. Additionally, the manufacturing processes are highly oriented toward cheaper fabrication techniques, such as solution-processed methods as spin coating, blade coating, and spray pyrolysis. These techniques have the potential to lead to large-area, cost-effective, ultrathin, and lightweight emitting devices. In particular, devices comprising either organic materials, halide perovskites, and inorganic electroluminescent thin film are of importance for the development of large-area self-emissive displays and white emitters.

Objectives of the thesis

The general objective of this thesis was to synthesize blue-emitting semiconductors, namely metal chalcogenide and hybrid halide perovskites, deposited by low-cost techniques using solution-processable methods, to subsequently incorporate them in electroluminescent devices.

The specific objectives were:

- Reproducible synthesis of ZnS:Eu thin film phosphor with strong blue emission by spray pyrolysis technique and incorporation in thin film electroluminescent (TFEL) devices.
- Reproducible fabrication and characterization of perovskite light-emitting diodes (PeLEDs) with strong blue emission using 2D-3D Ruddlesden-Popper perovskite phases, with nominal composition $\text{PEA}_2(\text{Cs}_{0.75}\text{MA}_{0.25})\text{Pb}_2\text{Br}_7$ and iPAm as additive.