Preface

This special topic volume ‚Advances in Light Emitting Materials' contains contributions in the field of silicon and III-nitride semiconductors. It starts with a brief history of visible light emitting diodes.

Silicon is expanding from microelectronics to photonics. Due to its indirect bandgap, it has not been the material of choice for optoelectronic integration. That is now beginning to change. Silicon devices have been developed with the capability to emit, modulate, guide and detect light and can be combined with microelectronics to form electronic and photonic integrated circuits.

The performance of silicon based light emitters has made important progress during the last years. The first paper describes the potential of D-band luminescence caused by dislocations in silicon and used for infrared light emitters. Silicon wafer direct bonding, which allows a controlled formation of dislocation networks, is described in detail in the subsequent paper. Then silicon and silicon-germanium light emitting diodes (LED), which emit band-to-band radiation, are depicted. The paper is followed by comments on the effect of carrier confinement on the emission of the band-to-band radiation of LEDs fabricated in silicon-on-insulator material. Finally, MOS light emitting devices based on rare-earth ion implantation are described. These structures show efficient electroluminescence for the wavelength range from UV to the visible light.

III-nitrides comprise AlN, GaN, InN and related alloy systems. These materials all have direct bandgaps, covering the range 0.6 eV to 6 eV, and double heterostructures (DHs) can be made with several combinations of these materials. The development of crystalline nitrides began four decades ago, but it was not until the groundbreaking discoveries two decades later that the development of electronic grade materials suitable for devices started. The invention of a thin polycrystalline AlN (or GaN) buffer layer deposited on top of a sapphire substrate turned out to allow the growth of very smooth layers of nitrides using Metal Organic Vapor Phase Epitaxy (MOVPE). The ability to dope the materials low-ohmic p-type was also discovered. Efficient blue DH LEDs on sapphire were commercialized already in the early 1990s. Later on thin (2-3 nm) quantum well (QW) structures grown in the polar (0001) direction were successfully used, to reduce the negative influence of strong polarization fields across the QWs. Laser diodes emitting in the violet region with an operating lifetime of 10000 hours were announced already 1997.

A brief introductory chapter summarizes early developments of III-nitride light emitters. Five more chapters focus on important directions of the present research in this field. One trend that is covered is the extension of the LED emission range deep into the UV, using Al containing alloy structures. Elaborate growth techniques are described, together with a discussion of important defect problems. One chapter concerns the development of a detailed understanding of the recombination processes of visible InGaN-based LEDs, using optical spectroscopy with high spatial as well as temporal resolution. A recent trend to develop emitters based on growth in non-polar or semipolar directions is also covered.

Bo Monemar Martin Kittler Hermann Grimmeiss