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A new type of white LED light source by bonding fluorescent SiC and a near-UV LED

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Abstract

Fluorescent silicon carbide (f-SiC) has advantages over phosphors in terms of abundancy, long lifespan, good thermal conductivity and high color rendering index [1, 2]. In this paper, we demonstrate a prototype of fluorescent SiC hybridly integrated with a near UV LED. The fabrication and characterization of the prototype are introduced and the future perspectives are foreseen.

The bonding process of an NUV LED and a B-N co-doped f-SiC epi-layer is shown in Fig.1. HSQ layers are spun on both the 4H-SiC substrate of the NUV LED and the polished backside of the free-standing f-SiC epi-layer. Afterwards, the NUV LED and the f-SiC epi-layer are placed with the surfaces covered by the HSQ layers in contact. During bonding at 400 °C, HSQ is converted into solid SiOx and by doing so the two samples are bonded together.

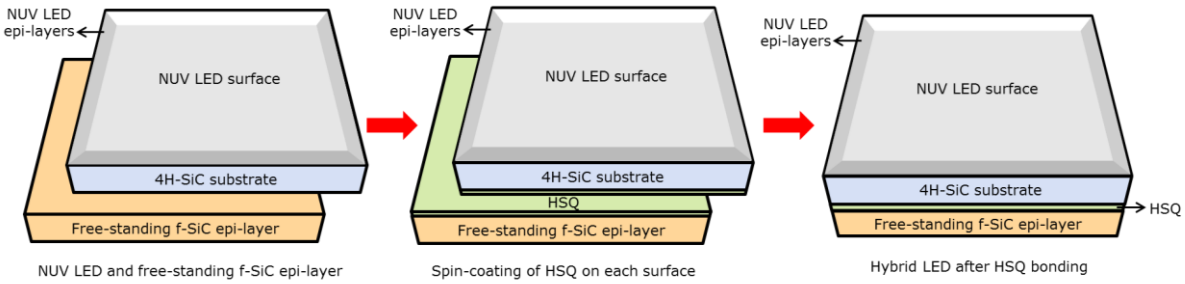

Fig.1 Schematic illustration of the bonding process of a NUV LED to a free-standing B-N co-doped f-SiC epi-layer assisted with HSQ layers spun on both SiC surfaces.

Through injection of an electric current to the hybrid LED, the generated NUV emission excites the B-N co-doped f-SiC epi-layer finally presenting a warm white emission, as shown in Fig. 2(a). Fig. 2(b) shows that the NUV LED before bonding presents a peak wavelength around 390 nm and after bonding, the emission of the f-SiC epi-layer can be clearly observed from the hybrid LED showing a peak emission wavelength around 550 nm. According to the results, it can be concluded that, HSQ bonding could be an effective approach in the SiC-related LED applications.

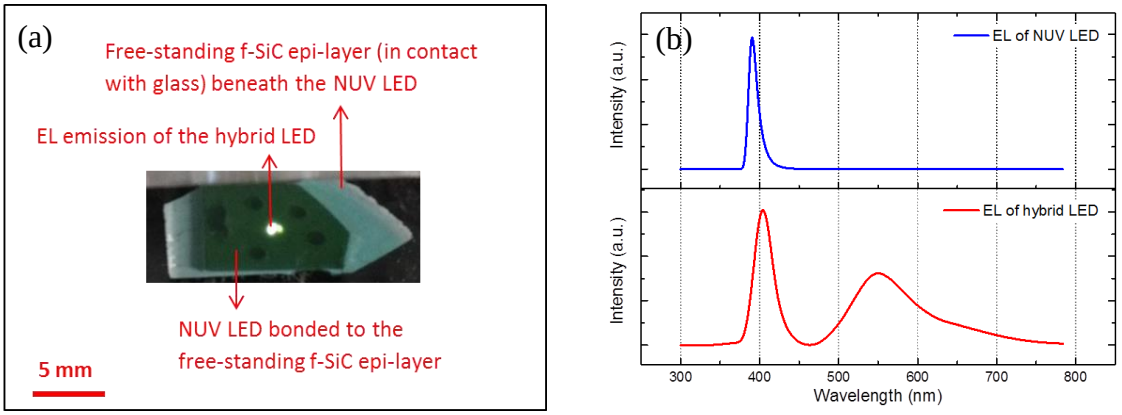

Fig. 2 (a) Photograph of the hybrid lighting LED from backside with electric current injection at 30 mA; (b) The EL spectra of the NUV LED before bonding and the hybrid LED measured from the backside at 30 mA.

Acknowledgments

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Reference

[1] Ou, H., et al., and Syväjärvi, M., "Advances in wide bandgap SiC for optoelectronics," Eur. Phys. J. B **87**(3), 58 (2014).

[2] Kamiyama, S., et al., and Syväjärvi, M., **"**White light-emitting diode based on fluorescent SiC," Thin Solid Films **522**, 23-25 (2012).

Haiyan Ou received the MSc from Huazhong University of Science and Technology in 1997 and PhD degree in semiconductor devices and microelectronics from the Institute of Semiconductors, Chinese Academy of Sciences in 2000. From 2000, she joined Technical University of Denmark, where she was promoted as associate professor in 2005. She has been a JSPS (Japanese Society for Promotion of Science) fellow at Meijo Univeristy (Japan), and a visiting professor at the Institute of Semiconductors, Chinese Academy of Sciences (China). Her scientific background is in the areas of materials and devices for optical communication, photovoltaics, and light emitting. She has published more than 212 peer-reviewed journal and conference papers, and is the founder of Light Extraction ApS.

Li Lin received the Bachelor of Science in Department of Optical Communication Science and Technology from Shandong Jianzhu University in 2012 and MSc in Department of Photonics Engineering from Technical University of Denmark in 2015 and MSc in Department of Physics and Technology from Yunnan University in 2015 and currently has her PhD Study in Department of Photonics Engineering from Technical University of Denmark since 2015. Her scientific focus is in the areas of light-emitting diode device fabrication, aluminum-doped zinc oxide as current spreading layers on gallium nitride-based near-ultraviolet light-emitting diodes and adhesive bonding of HSQ in SiC-related LED applications.