TAILORED LIGHT

Optical Technologies.

New LED-based white light source with tunable color temperature

Supervisor: Dr. rer. nat. Merve Wollweber, HOT

Co-Supervisors: Prof. Dr. Bernhard Roth, HOT
Prof. Dr. Uwe Morgner, IQ/HOT

Project ID: A6

Ultrabright white light-emitting-diodes (LED) are much more efficient than compact fluorescent lamps and hence are rapidly capturing the market for general illumination. LEDs are also replacing halogen lamps or even newer xenon based lamps in the automotive headlamps.

A typical white light LED is made of a blue LED chip covered by a phosphor coating, which can be realized in various geometries (Fig. 1). Due to phosphorescence, a part of the blue light absorbed by the phosphor is frequency-down converted to a wide band of spectrum from green to red, and this being mixed with the unconverted blue light gives a white light output with a certain color temperature. The resulting color temperature depends on several parameters like the peak blue wavelength, the chemical composition of the phosphor, etc., and so the color temperature of any such white LED is fixed as determined by the LED-phosphor design.

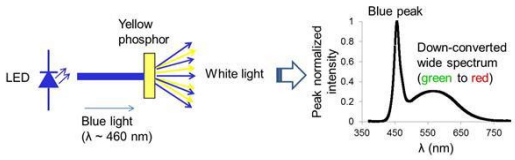

Fig. 1: Generation of white light using a blue LED to pump a broad band emitting phosphor.

Lighting applications usually have specific requirements with respect to the color temperature or spectrum of the light source. So far, one can usually find a warm white or cool white LED or multi-LED lamps in the market. Cool white LED lamps qualify for work desk lighting but are for example not appropriate for bedrooms or restaurants, where a warm white lamp is generally preferred. Similarly, typical bluish white or cool white LED based headlamps give a perception of higher brightness to human eyes but are worse in fog situations when one would prefer warmer white to reduce scattering and glare and enhance visibility.

Medical applications call for even finer differentiations. In dermoscopy, for example, light sources that specifically enhance contrast and visibility of diagnostic criteria are highly desirable. Such diagnostic criteria may be skin features like color and distribution of melanin, for example for melanoma screening, or features connected with vascularization and inflammation, which generally benefit from good hemoglobin contrast. In order to be able to image the same target with different specialized lighting, the development of a white light source with tunable color temperature is envisaged for this project (Fig. 2).

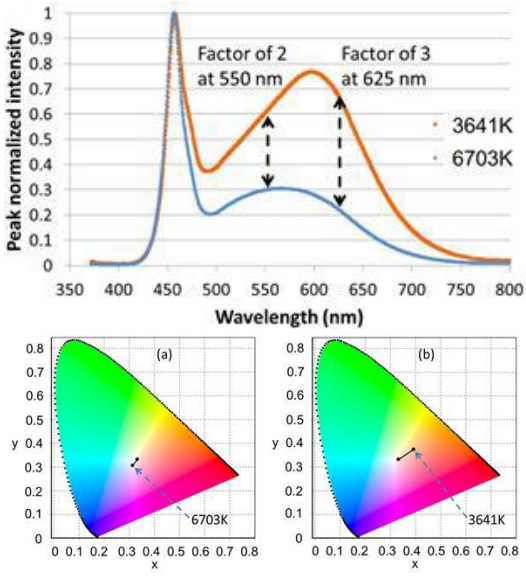

Fig. 2: Tailored color temperature by using different phosphors represented by their spectrum (top) and color map (bottom).

TAILORED LIGHT

Optical Technologies.

New LED-based white light source with tunable color temperature

So, in this project of the graduate school 'Tailored Light', an LED or laser based white light source with tunable color temperature shall be developed and validated for application in medical imaging. The new lighting system is to be modeled, designed, and constructed; to be characterized with respect to spectral tunability, efficiency, and ageing; and to be evaluated for dermoscopy as its medical application. The HOT cooperates with the Division of Immunodermatology and Allergy Research, Department of Dermatology and Allergy, Hannover Medical School, so testing and evaluation of the new lighting system for the application is possible under real conditions and with competent feedback from experts in dermatology. Criteria for the evaluation will be both subjective assessment by our dermatologic partners as well as objective studies with the goal to become able to establish a reliable correlation and possibly prediction of physically defined metrics and physiological appearance and rating of color and contrast. This also includes image processing by customized or new processing algorithms to systematically improve visibility of diagnostic features in the dermoscopic images. These algorithms need to be designed on the basis of the dermatologist's requirements, implemented, tested and evaluated also establishing another feedback-loop for the light source design.

Long-term considerations aim at a significantly improved light source for dermatologic applications that can be integrated in a new generation of hand-held dermoscopy devices with a much wider application range than contemporary systems.

We expect prospective PhD student to have a strong background in optics with an emphasis on optics design, modeling and characterization as well as experience in experimental optics.

This is a PhD-project of Tailored Light. Tailored Light is a coordinated PhD-programme of the Hanover Centre for Optical Technologies from the Leibniz Universität Hannover together with the Hochschule Hannover, the Laser Zentrum Hannover, the HAWK Hildesheim/ Holzminden/ Göttingen, the TU Braunschweig and the TU Clausthal.

Students interested in this or another project of Tailored Light can apply for fellowships. Have a look at www.tailored-light.uni-hannover.de for details.