Light Management for Treatment of Chronic Wounds

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Chronic wounds represent a significant burden to patients, health care professionals, and health care systems, affecting over 40 million patients and creating costs of approximately 40 billion € annually. In the European project "MEDILIGHT" CSEM and its partners work on the development and fabrication of a medical device for professional wound care. The device will use recently proven therapeutic effects of visible light to enhance the self-healing process and monitor the status and history of the wound during therapy. Exposure of the chronic wound with certain colors and durations can induce the growth of keratinocytes and fibroblasts in deeper layers of the skin and is also known to have antibacterial effects predominantly at the surface layers of the skin. In order to be compliant with hygiene requirements the system consists of two main parts: 1) the wound dressing with the illumination system, and 2) the electronics for the controlling and the wireless communication. The disposable wound dressing hermetically seals the infectious wound whereas the illumination system can be reused during the treatment of one and the same patient. The illumination system is based on a LED foil and thin light management layers which makes it thin and mechanically flexible. It also comprises heat management structures and provides the required degree of breathability.

In the European project MEDILIGHT, CSEM developed an illumination system for the treatment of chronic wounds by means of elaborated illumination schemes. As shown in Figure 1, the MEDILIGHT systems consists of the wound dressing provided by the industrial partner Laboratoires URGO, the flexible illumination system, and the electronics for the controlling, the data acquisition and the wireless communication.

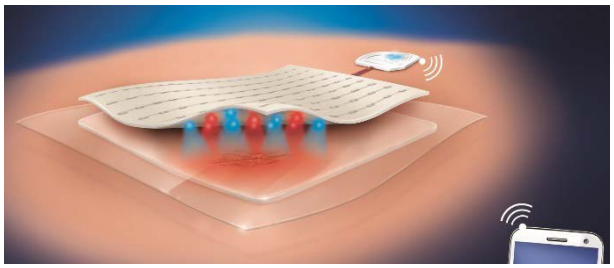

Figure 1: Illustration of the MEDILIGHT wound healing system. It consists of a disposable wound dressing, an exterior flexible illumination system with sensors and the controlling electronics.

The illumination system is positioned on top of the disposable wound dressing and consists of a flexible LED foil with homogenizing micro-optical layers on top, which provide a high level of illumination homogeneity in combination with high illumination efficiency; even when in direct contact with the flexible LED foil. The flexible LED foil is additionally fitted with a light harvesting layer collecting and redirecting misdirected light back to the wound.

The thin portable and mechanically flexible illumination system developed by CSEM provides an adjustable intensity density of up to 25 mW/cm^2. It also provides enough breathability to allow the patient's exudates to be lead away as well as it provides integrated heat management structures to dissipate the heat generated by the LEDs.

Figure 2 shows the developed illumination system and the attained homogeneity.

Figure 2a shows the measurement of the homogeneity as well as the cross-section on the right. The tiny bright spots that can be seen (the peaks in the cross-section view) are not the LEDs but the tiny openings which belong to the URGO wound dressing. A homogeneity (Imin / Imax) of 62% was achieved.

Figure 2b shows a photograph of the demonstration of the illumination system with one of the wound dressings developed at URGO for best optical efficiency. The size of the demo is 16 cm^2. Larger patches of up to 72 cm^2 based on flexible LED foils providing exactly the same power densities and homogeneity have also been built.

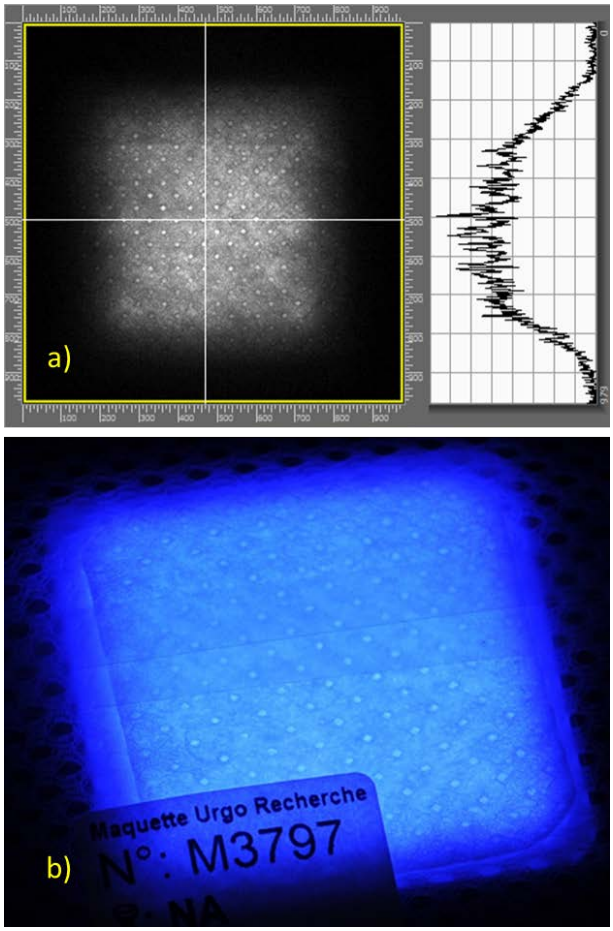

Figure 2: First demo of the thin 16 cm^2 MEDILIGHT illumination system. The demo consists of 32 LEDs, diverse light management elements for light redirecting and homogenization as well as the complete wound dressing from the industrial partner URGO on top. The illumination system is able to provide high intensities up to 25 mW/cm^2.

The project MEDILIGHT is funded by the European Commission (grant agreement no. 644267) and builds on the competencies of the following partners: Technical University of Berlin (Germany), Laboratoires URGO (France), Ruprecht-Karls-University Heidelberg (Germany), CSEM (Switzerland), SignalGeneriX Ltd (Cyprus), Microsemi Semiconductor Limited (United Kingdom), and AMIRES s.r.o. (Czech Republic).