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WHITE PAPER

Preliminary cytocompatibility studies for encapsulated OLEDs

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Light therapy is an important means of promoting the healing of wounds. Difficult and protracted healing processes of the skin, such as are due to chronic and infected wounds, present a challenge for treating physicians and can be positively affected by exposure to light.

Feasibility studies for accelerating wound healing using LED and OLED light are found in the literature and have been demonstrated in cell cultures as well as in mice and rats. Therapeutical methods based on LED light are already in clinical use. The disadvantage of LED therapy is that macro-area irradiation able to be applied close to the body is associated with high technical complexity and expense as well as with an undesirable generation and exposure to heat. Flexible OLEDs (organic light-emitting diodes) that Fraunhofer FEP has been working with for years could offer an interesting alternative light source here thanks to their light weight, flat geometry, yet physical flexibility. Their flexibility means OLEDs can conform to the specific affected area of the body.

Fraunhofer FEP works on technologies and applications for flexible OLEDs. In order to be able to employ these area light sources for potential medical applications though, any potential toxic effects caused by the constituent materials must be precluded. No studies on cytocompatibility, or tolerance of cells to flexible OLEDs were known of to date.

An initial pilot study on in vitro cell cultures afflicted by defined damage has been carried out at Fraunhofer FEP. The cell cultures consisted of samples of the skin (human fibroblasts and human keratinocytes) and of the immune system (human T-lymphocytes) for characterizing the influence of green and cold-white OLED light. For this purpose, the vitality and mitochondrial membrane potential of the cells was measured following treatment with light.

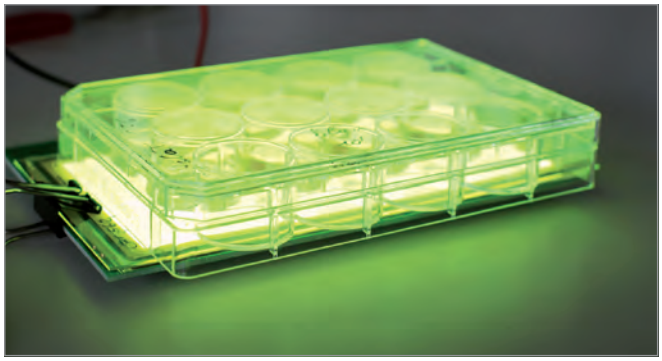

Photo 1: Green OLED light during physical stimulation of cells (OLED and cell culture plate)

Positive stimulation of the damaged cell cultures of the upper epidermal layer by green light could be detected. If the results of the preliminary studies with the effect of physical stimulation of the cell are transferred to biophysical therapeutic treatments, then the findings indicate an effect of accelerated auto-recovery and thus could be the potential foundation for future therapeutic applications.

The initial findings on cytocompatibility for flexible OLED systems have since become available. Various flexible OLEDs with 10 cm × 10 cm luminous areas were tested in accordance with DIN/ISO 10993-5 "Part 5 – Testing for In vitro cytotoxicity" for biological evaluation of medical products. An in vitro cell culture of skin (human keratinocytes) was utilized again as the cell line.

The potential effects of toxic substances were investigated that may diffuse from the OLEDs due to electrical operation or mechanical loading caused by bending, and which could alter the shape, the number, and metabolism of cells. Comparative studies and long-term tests showed no cytotoxicity in the material systems investigated.

Additional long-term studies are anticipated in order to be able to guaranty the effects of the OLED light. Safe electrical connections, power supplies, driver circuitry, and component perimeter seals are additional important aspects that researchers at Fraunhofer FEP are working on – before direct application to the patient is allowed. Fraunhofer FEP continues to seek additional interested partners for applications-oriented product development related to this work.

Detailed findings will be presented by Dr. J. Hauptmann in her talk entitled "OLED light application in medicine and cytotoxicity of the materials" during the 4th Industry Partners Day devoted to medical topics at Fraunhofer FEP on September 28, 2016.
The studies were carried out in cooperation with the Anhalt University of Applied Sciences through student projects. The authors wish to thank Prof. Michael Zimmermann, Sarah Hoffmann, and Rajon Deb Nath from the Anhalt University of Applied Sciences for their amiable support and collaboration.

Photo 2: Flexible OLEDs produced at Fraunhofer FEP using roll-to-roll processing