PHOSPHORESCENCE BASED HYBRID ILLUMINATION SYSTEM

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EXTENDED ABSTRACT

Key Words: autonomous line lighting, systems, phosphorescent tapes, hybrid illumination**,** illumination intensity measurements.

1. INTRODUCTION

Passive and active visibility of subjects (especially pedestrians) is one of the key issues of road safety. Majority of solutions are based on the utilization of retroreflective materials functioning under direct illumination from external light sources only. These solutions indicate only the presence, but not the real size and shape of subjects, which may be a source of problems and the cause of road accidents. Passive safety features also respond only to direct illumination, and the subject is not able to accurately assess whether it is truly visible. Active light emitting diode (LED) do not indicate the size of the subject's silhouette, and are also sensitive to mechanical stress (especially repeated bending). The aim of this work is to analyze a combination of active and passive lighting elements as a parts of hybrid illumination system. This system is constructed for clothing purposes mainly. As active lighting element, the linear composite consists from side emitting optical fiber covered by woven textile layer, power supply and LED light sources was developed [1]. This system was successfully used for purposes of safety illumination of warning cloths and for temporary line illumination in remote areas.
Passive lighting element is composed from textile tape coated by fluorescent pigments which emit light even after the active lighting is temporarily switched off. The selection of proper fluorescent pigments is based on measurement of time to decay of illumination intensity to the limited value of sufficient visibility in the dark. The combination of active and passive illumination leads to the extension of total illumination time. The analysis of hybrid illumination system is realized by the special testing system enabling to measure the time course of illumination intensity in the phase of active and passive lighting. Based on the analysis the final hybrid system is designed and used as a part of special clothing.

2. AUTONOMOUS LINE LIGHTING SYSTEMS

Autonomous Line Lighting Systems (ALSO) are illumination systems enabling line lighting with local portable power source as battery or power bank. ALSO are commonly designed as LED fields connected by (metallic) conductors or as the end emitted polymeric optical fibers (POF) micro-bended due to their incorporation into woven or knitted fabrics respectively [2]. Illumination intensity of micro-bended POF is not sufficiently high, there are problems with connection to LED and there are limitations of durability due to low bending radius. LED fields have sufficient illumination intensity but have a number of disadvantages such as local heating, higher energy consumption limiting operating time and sensitivity to mechanical stress.

The expedient is the construction of an autonomous linear light beam system based on side-emitting optical fibers which eliminates or at least severely restricts the disadvantages of the previous solutions. There are also basic areas for possible use of ALSO for actively emitting garments and local lighting in places where there is no access to electricity from the grid.

3. ILLUMINATION SYSTEMS BASED ON SEPOF

We developed ALSO composed of linear composite LK (see fig. 1b) as side-emitting optical fibers (SEPOF - see fig. 1 a) covered by special textile layer enhancing illumination intensity (fig. 1a), power source, and LED light sources (fig. 1c) [1, 3, 4].

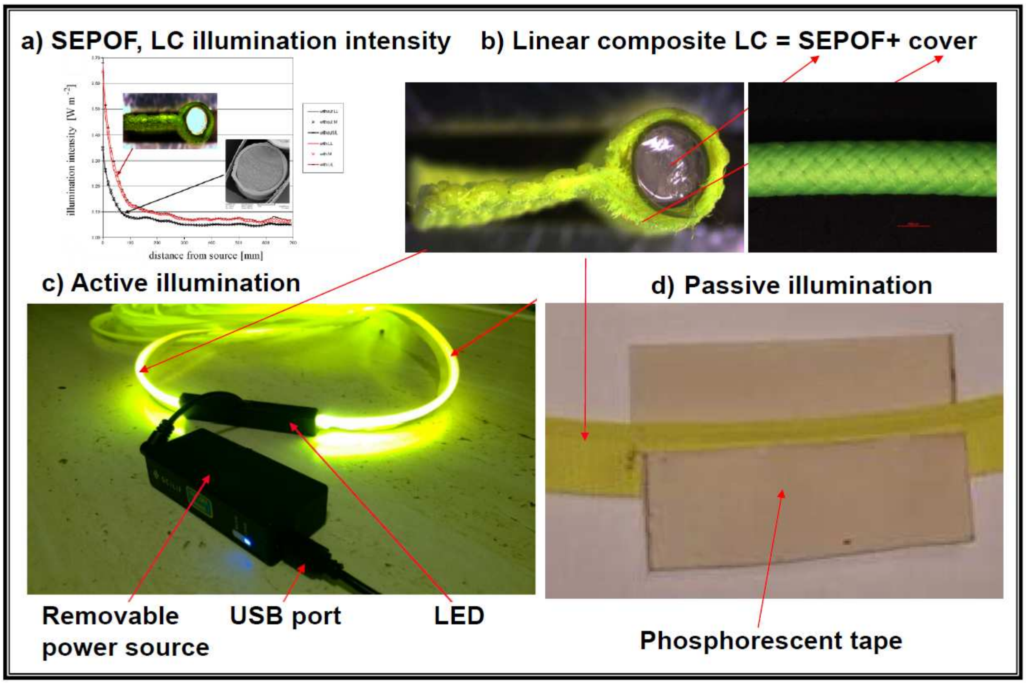

Figure 1. Systems ALSO based on SEPOF

These ALSO systems have a good homogeneity of radiated light, they can alternatively convert a portion of the UV radiation into the visible area; provide high resistance to external influences, etc. All of the ALSO parts can be optimized for the needs of the area of use. Major limitation for long term use is capacity of battery which is able to guarantee the active lighting for 6 - 8 hours only. One simple possibility is to use blinking with suitable frequency [4].

4. HYBRID ILLUMINATION SYSTEMS

Motivation for construction oh hybrid ALSO is partial utilization of side emitted light from LC for activation of passive lighting tape. This element is composed from textile tape coated by fluorescent pigments which emit light even after the active lighting is temporarily switched off. The selection of proper fluorescent pigments is based on measurement of time to decay of illumination intensity to the limited value of sufficient visibility in the dark. Based on the comprehensive testing it was found that for ensuring the activation of the phosphorescent active layer, which is typically placed under LC, it is necessary to select a suitable LED (typically white) and a suitable color (usually white) of SEPOF cover providing emission in the low wavelength region. It has been verified that tape material should be hydrophobic (e.g. polyester fabric). Aqueous coating based on butadiene-styrene containing a phosphorescent pigment, acrylic components increasing abrasion resistance and polyurethane flexibility enhancing components is ensuring sufficient phosphorescence intensity for at least 10 minutes. It was found that time of re-activation of phosphorescence in the range of 5 - 15 min is not very important for passive illumination intensity decay (fig. 2).

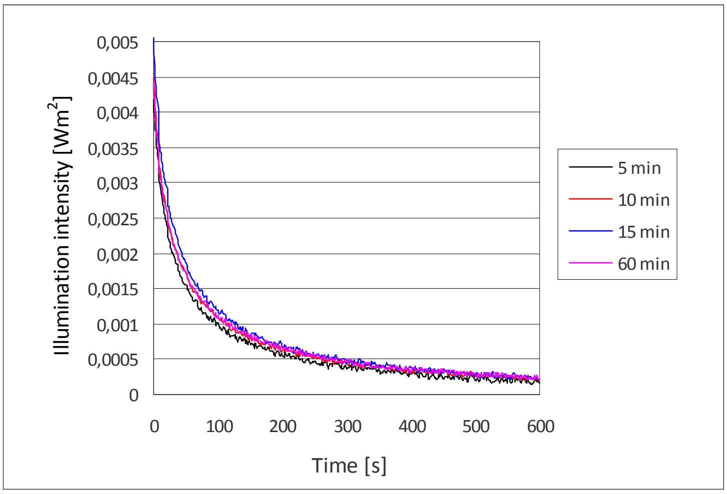

Figure 2. Illumination intensity due to phosphorescence as function of activation time

For the reactivation time 10 min and 10 min of passive lighting it saves 30 minutes per hour when compared with active ALSO system. Therefore, with a standard 7 hour power supply function, the hybrid ALSO containing phosphorescent layer will increase to 14 hours. The combination of active and passive illumination leads to enhance of illumination power about 20 % as well.

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