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DEGRADATION OF PRINTABLE OPTICAL FILTERS FOR VISIBLE OPTICAL COMMUNICATION

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ABSTRACT

We demonstrate the design and production of tailored printable optical filters for visible optical communications. The filters spectral characteristics were evaluate under extreme climatic conditions, namely, high temperatures and UV exposition.

Keywords: free-space optical communication; wavelength filtering devices; UV exposition.

INTRODUCTION

Optical wireless communications (OWC) is an energy-efficient emerging area, being developed by several researcher groups seeking high bandwidth, high security, using visible light instead of radio-frequency or microwave signals. Previous studies have shown that it is possible to achieve, with these systems, a bandwidth of 500 Mbps (Lin, 2012). The implementation of OWC systems using white light emission from commercial Light Emission Diodes (LED) was initial proposed by Komine and Nakagawa in 2004 (Komine, 2004). The utilization of LED sources opens a window of opportunity for wavelength division multiplexing (WDM) (Cui, 2009). However, the implementation of this solution requires cost effective optical filtering devices. Despite the commercial interest of the VLC technique, few works have been devoted to the subject (Uddin, 2011). In this work we propose the design of novel optical filters ink-jet printed in transparencies as a low cost solution for the large scale implementation of OWC systems. Moreover, we study the degradation of these filters under extreme climacteric conditions. The development of the commercial inkjet printers opens the possibility to create tailored high dynamic range optical filters. These printers are based on a subtractive color model, usually the CMYK model, which refers the 4 primary color used for printing, namely Cyan (C), Magenta (M), Yellow (Y) and blacK (K). Since we are interested in transmission optical filters printed in transparent substrates, the Murray-Davies model can be used, considering the spectral transmittance of the Neugebauer primaries and the Demichel equations (Amidror, 2000). However, the printing and the measurement of the Neugebauer primaries is impracticable for commercial inkjet systems. Other proposed approach is based on the principal component analyses but requiring a high computational calculus to obtained the final transfer function (McElvaina, 2009).

RESULTS AND CONCLUSIONS

The 4 primary colors were printed in a BASF inkjet transparency with 200 μm thickness, using an HP8100 inkjet printer. The spectral transmittance of each primary was measured using a dual-beam spectrometer Lambda 950, (Perkin-Elmer) with a 150 mm diameter

Spectralon integrating sphere. Figure 1 shows the transmittance spectra for the primary colors (C, M, Y and K) and for the substrate (transparency).

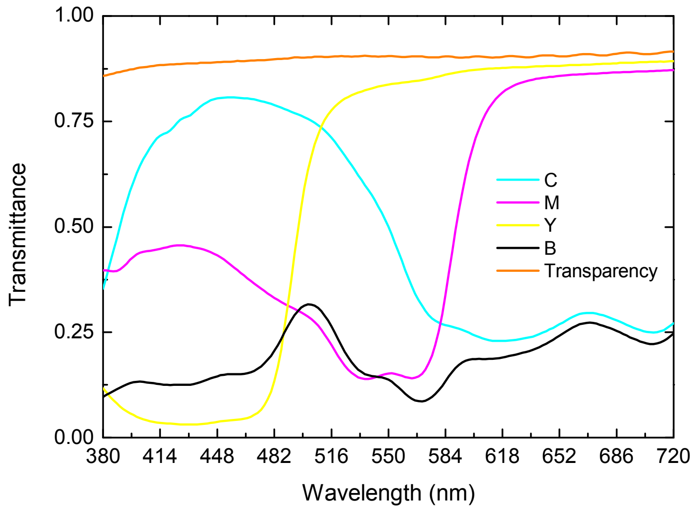

Fig. 1 - Transmittance spectra for the 4 primaries and for the substrate (transparency).

In order to visualize the color difference between the specified color and the measured one a uniform chromaticity scale color space CIE (u',v') chromaticity diagram was built using D65 illuminant and a 2º standard observer. The color difference between the specified one and the obtained filter transfer function was further quantified using the CIE (L*,a*,b*) color space (CIELAB, for the D65 illuminant and the 2º standard observer).

We have demonstrated the production feasibility of tailored printer optical filters. The filters transfer function was optimized using a color model based on the Murray-Davies, using the CMYK primaries. The filters spectral characteristics were analyzed under an accelerated aging conditions, namely by the exposition to high temperatures and UV radiation.

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