SHORT TERM SCIENTIFIC MISSION (STSM)
SCIENTIFIC REPORT

This report is submitted for approval by the STSM applicant to the STSM coordinator

Action number: COST Action FP1405
STSM title: Light fastness of liquid crystal - based thermochromic printing inks
STSM start and end date: 11/02/2019 to 15/02/2019
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PURPOSE OF THE STSM:

Short - term scientific mission included research of light fastness of liquid crystal - based thermochromic printing inks, which is a part of post doctoral research. Short - term scientific mission was conducted at National Institute of Chemistry (Ljubljana, Slovenia) at Laboratory for Materials Chemistry, under mentorship of assoc. prof. dr. Marta Klanjšek Gunde.

Light fastness of liquid crystal - based thermochromic printing inks is of great importance for applications on intelligent packaging and other temperature-indicating applications. The main purpose of the STSM was to investigate the light fastness of liquid crystal - based thermochromic printing inks and to prepare these results for scientific article in an impacted journal. Detailed evaluation of the light fastness properties of thermochromic liquid crystal - based (TLC) printing inks is needed for better understanding of properties and applications of TLC printing inks. The obtained results will be compared to previous research. The cooperation between two research groups is strengthen through this mission.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

Previously prepared TLC prints were used in this research. The samples were printed on black uncoated paper with water-based printing ink used for screen-printing. Activation temperature (T_A) of TLC printing ink is 25°C and temperature activation region is 5°C. Inside temperature activation region the color play effect of TLCs can be observed. All color changes are reversible. TLC samples were exposed to natural ageing in indoor conditions, inside the office window glass. The prints were also exposed to light inside the Solarbox 1500e chamber in varying time periods, up to 15 hours. The heated TLC samples were measured with USB 2000+ spectrometer using integrating sphere. The samples were heated to certain temperature (°C) with temperature controlled system, specialy designed for measuring thermochromic samples.
Temperature dependent reflectance spectra of exposed samples were measured over the entire activation region and the corresponding CIELAB colors were calculated. Some TLC samples were protected and analyzed the same way. The optical effect of TLC prints in various exposure times was described by spectrometric measurements.
In this STSM, the results of the broad research were analysed and prepared for a scientific publication in an impacted journal. The obtained results were compared to the former data and completed with a few measurements necessary for this research. The literature was systematicly studied to achieve all existing data useful for the proposed analysis.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

Specific temperature dependant optical properties of TLC printing inks drastically change during exposure to daylight conditions. The results of this study show how the size of the color loop on the *a*b** diagram and the activation region changes with exposure of the TLC prints. The exposure to light influences the size of the color loop on the *a*b** diagram; the first effect of the exposure could be observed as increased saturation of the color, which becomes weaker with longer exposures. One of the most important effect are the changes in the hue angle of the color, which is not the same or similar with exposure of TLC samples to light. This effect is best showh in *a*b** diagram, where the hue angle shifts in anticlockwise direction. The results show the instensity of TLC ink is changing with longer exposures and the temperature at wich these colors appear shifts to lower values. Similar results were obtained for the samples exposed inside the Solarbox 1500e chamber. Exposure to simulation of daylight conditions gradually leads to a complete loss of color play effect. This is an important information for TLC printing inks because it shows how exactly their properties change during exposure to daylight and how they could be protected.
The research shows that the TLC inks should be used for applications aimed to shorter light exposures (weakly illuminated and for shorter times). If TLC printing inks are used for longer period, they should be suitably protected against UV radiation. If TLC printing ink are not protected against UV radiation, the color play effect consecuently becomes unobservable and TLC inks lose their function. The results of this research could contribute in creating guidelines for applications using TLC printing inks.

FUTURE COLLABORATIONS (if applicable)

The proposed study could give new insights in development of commercial applications which are using TLC inks and possibly in reducing limitations for more widely usage in the areas of smart packaging and temperature indicators, security printing and brand protection.