Study of thermochromic materials and their properties for visual indicators

Robert Král[1], Lucin Fortin[2], Petra Zemenová[1], Morgane Poupon[1], Alex Nicaise[2], Jan Pavel Šafrata[3], David Daniel Šafrata[3], and Joris More Chevalier[1]

[1]*Institute of Physics, Czech Academy of Sciences, Cukrovarnicka 10, 162 00 Prague, Czechia*
[2]*Polytech Nantes, Rue Christian Pauc, CS 50609, 44306 Nantes Cedex3, France*
[3]*Gymnázium Evolution Sázavská, Sázavská 830/5, 120 00 Prague, Czechia*

Recently, chromogenic materials brought attention due to their wide application potential [1]. They belong into a broad family of functional materials containing discoloration substances and other auxiliary components, which change color when exposed to varying external conditions such as temperature, pressure, gas, etc. Specific group are the thermochormic materials, also called as temperature sensitive material(s), with unique color change occuring (reversibly or irreversibly) under thermal treatment [2]. Thus, these materials can be applied in scientific, industrial, and technological applications due to their ability to provide visual indication of thermal changes at specific environmental conditions or external influences. This may be used in aerospace, military, smart windows (to block solar radiation), printing technology, textile, architectural coatings, etc. [2,3]. However, the most significant application may be ascribed to food packaging and food safety, to monitor whether the food was properly stored while transported.

Our main goal is to study selected thermochromic compounds based on Co- and Ni-phosphites to understand the mechanism behind their color properties and changes. However, due to their complex composition, which results in multiple transitions and decompositions at higher temperatures, we decided to firstly study thermochromic transitions on model compounds such as cobalt chloride hexahydrate ($CoCl_2.6H_2O$) and nickel chloride hexahydrate ($NiCl_2.6H_2O$).

In this work we explored and analyzed properties of above mentioned model compounds using various thermoanalytical methods e.g. thermomicroscopy, simultaneous differential thermal analysis and thermogravimetry coupled with mass spectrometry, and thermomechanical analysis. Further, their structural and physical properties were investigated as well.

The work is supported by Operational Programme Johannes Amos Comenius financed by European Structural and Investment Funds and the Czech Ministry of Education, Youth and Sports (Project No. SENDISO – CZ.02.01.01/00/22_008/0004596).

[1] D.K. Nguyen, Q.-V. Bach, J.-H. Lee, I.-T. Kim, Materials 11 (2018) 1693.

[2] Y. Cheng, X. Zhang, C. Fang, J. Chen, Z. Wang, J. Mater. Sci. Technol. 34 (2018) 2225.

[3] W. Yu, Y. Zhou, Z. Li, D. Zhu, L. Wang, Q. Lei, C. Wu, H. Xie, Y. Li, Appl. Energy 372 (2024) 123821.