Innovative two-component luminescent sensory systems for on-line monitoring the process parameters of chemical reactions, applicable to the optimization of production lines in the coating industry

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Description of invention

Two-component luminescent sensor systems are designed to optimize the parameters of film-forming processes in real time. The measurement system includes a molecular luminescent temperature sensor and a kinetic sensor. By analyzing the response of the temperature sensor during the process, it is possible to determine the temperature change caused by the course of the polymerization reaction. Because the temperature sensor used is of a molecular nature, it is characterized by practically zero inertia, which distinguishes this technique from other methods of temperature monitoring. In turn, by analyzing the response of the kinetic sensor, parameters such as induction time and initial polymerization rate can be determined. Based on the results obtained with the use of both sensors, additional parameters describing the polymerization process of great practical importance, such as the total heat of polymerization reaction, can be obtained. Adjustment of these parameters is necessary to obtain a fully cured, smooth coating. Thanks to real-time monitoring of key process parameters, it is possible to adjust and change these parameters using appropriate devices without stopping the technological lines in response to possible sudden changes in the mixture, which can prevent production from stopping. This method allows for a significant reduction in equipment costs compared to classic solutions such as DSC.

Schematic diagram of the measurement apparatus

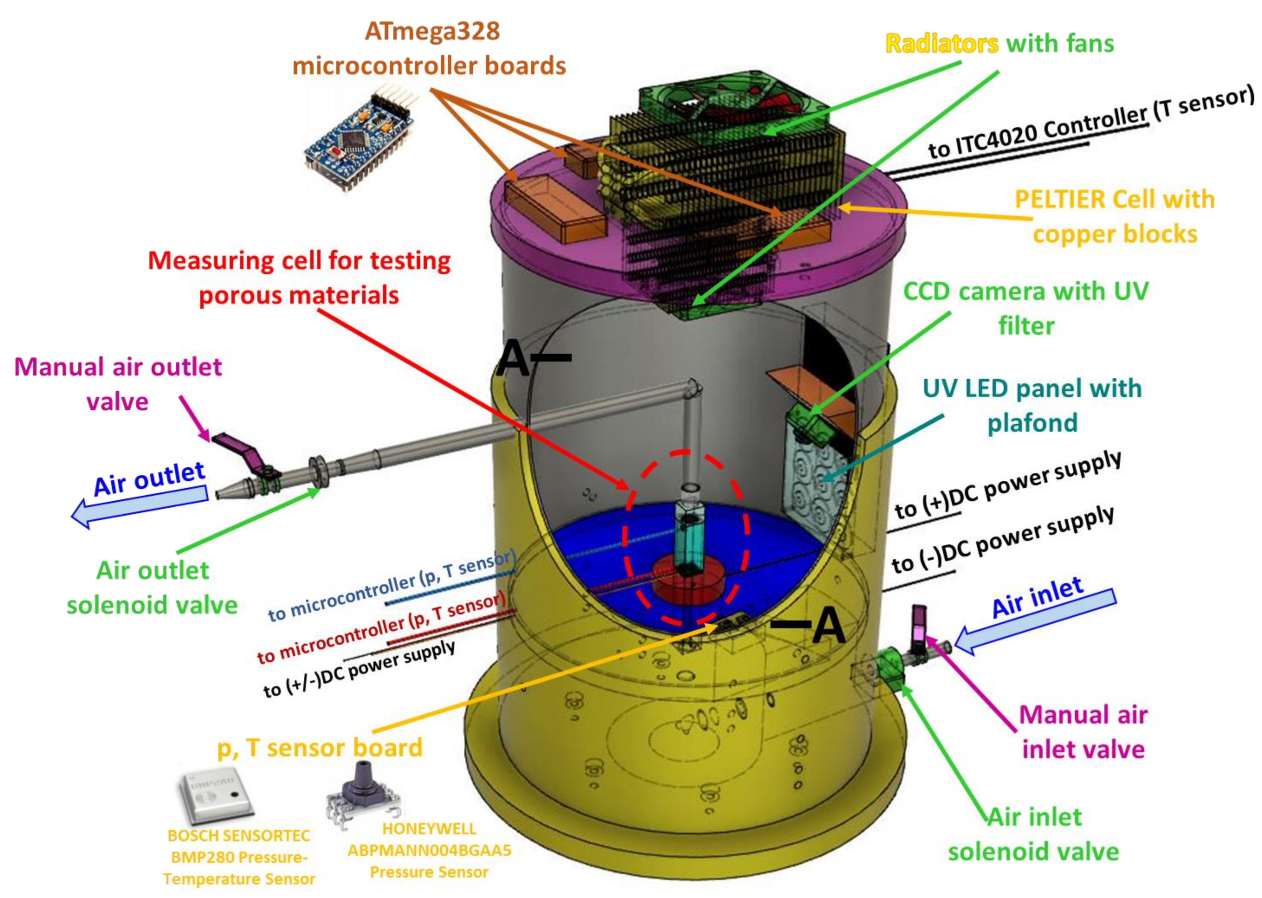


Fig.1. Diagram of apparatus for kinetic-calorimetric measurements

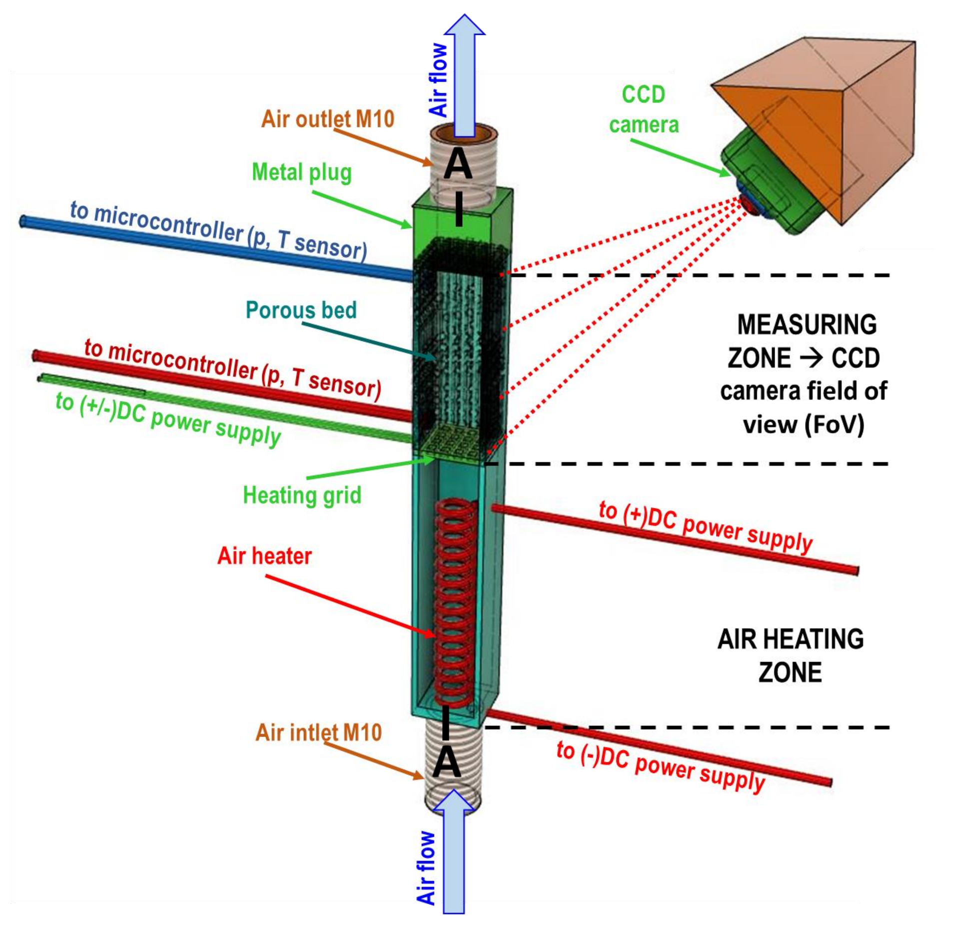


Fig.2. Listed diagram of the measuring chamber of the kinetic-calorimetric measurement apparatus

Method of analysis

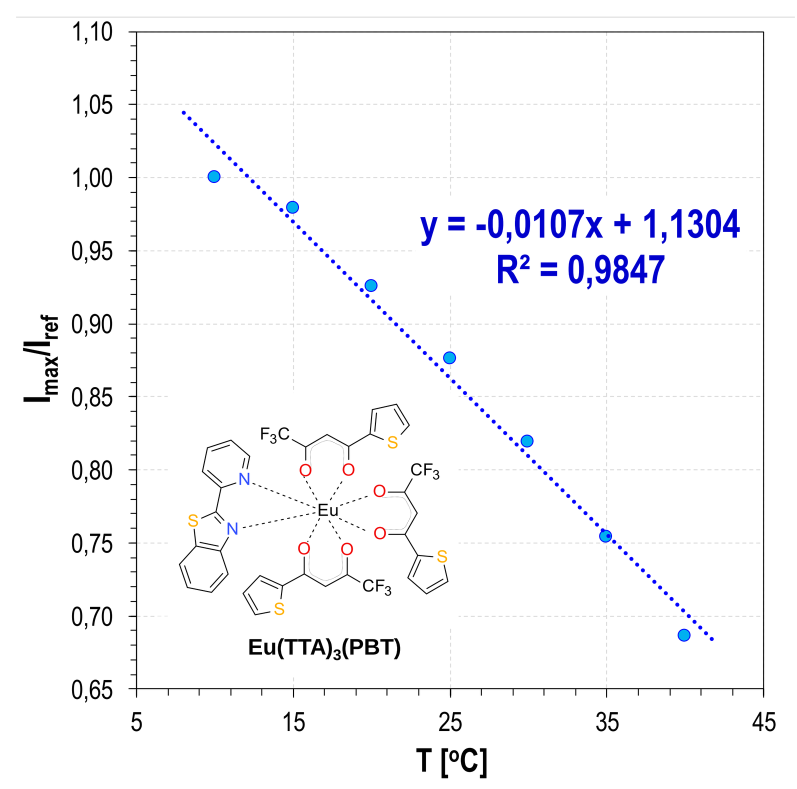


Fig.4. Change in the luminescence spectrum of the Eu(TTA)3(PBT) sensor, in a cured p-TMPTA polymer coating, in the temperature range from 10°C to 40°C (tint=1000s).

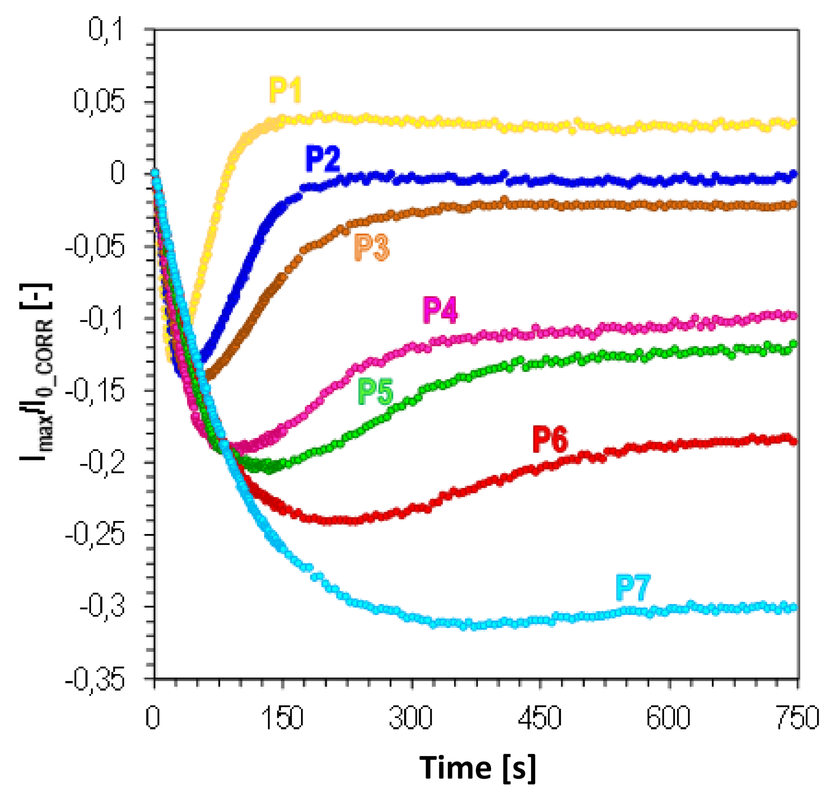


Fig.5. Temperature profiles of the radical photopolymerization reaction of TMPTA acrylic monomer, labeled with a two-component luminophore system, at different concentrations of OMEGA initiator (for P1-P7 samples 0.500; 0.300; 0.200; 0.150; 0.100; 0.050; 0.025 (% m/m), respectively). after applying compensation for the photolysis effect of the sensor.

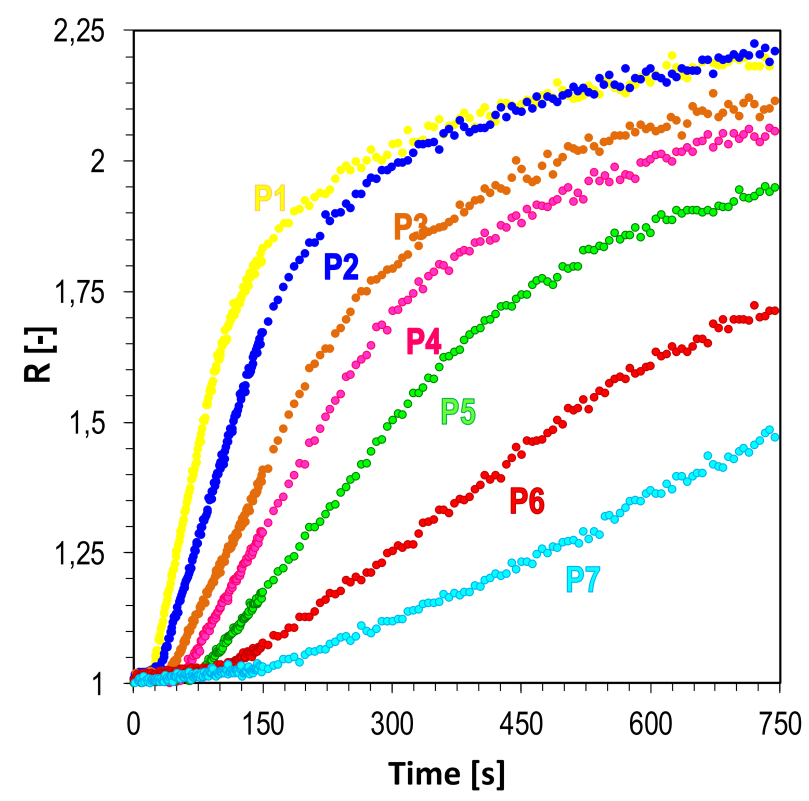
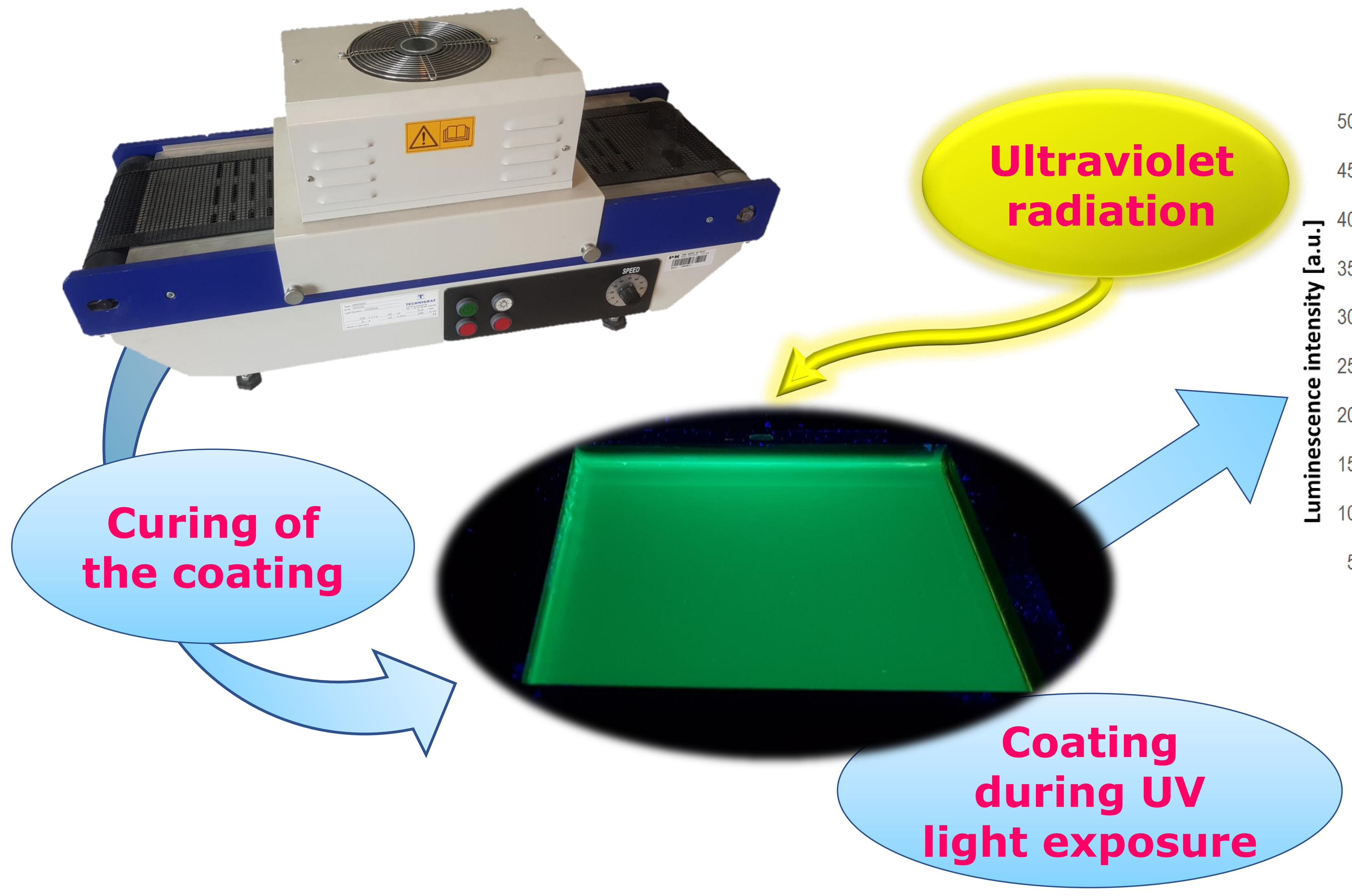


Fig.6. Kinetic profiles of the radical photopolymerization reaction of TMPTA acrylic monomer, labeled with a two-component phosphor system, at different concentrations of OMEGA initiator (for P1-P7 samples 0.500; 0.300; 0.200; 0.150; 0.100; 0.050; 0.025 (% m/m), respectively).

Scheme of invention



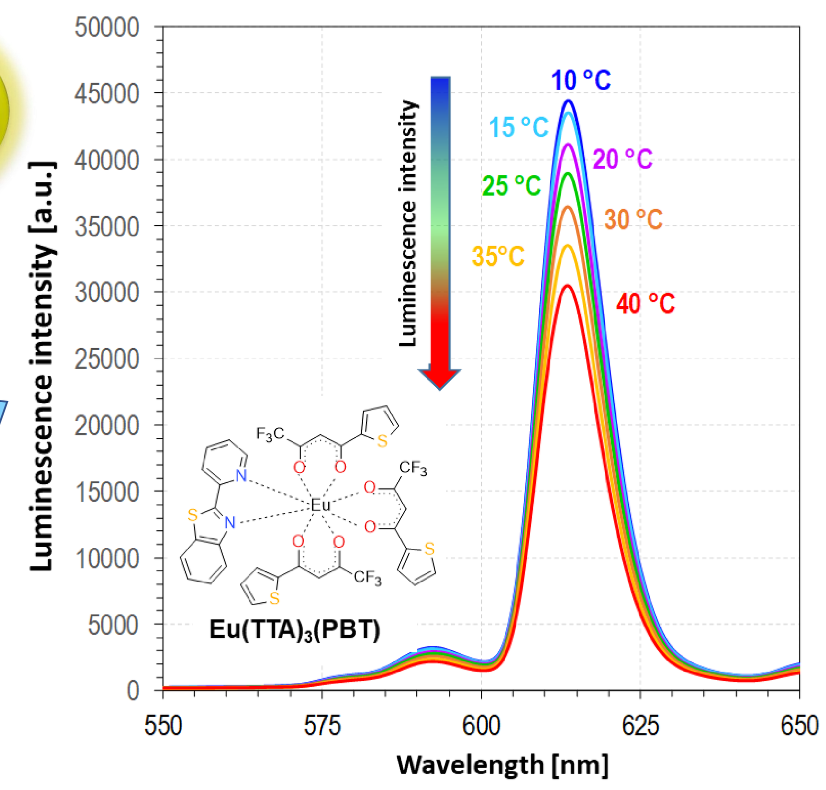
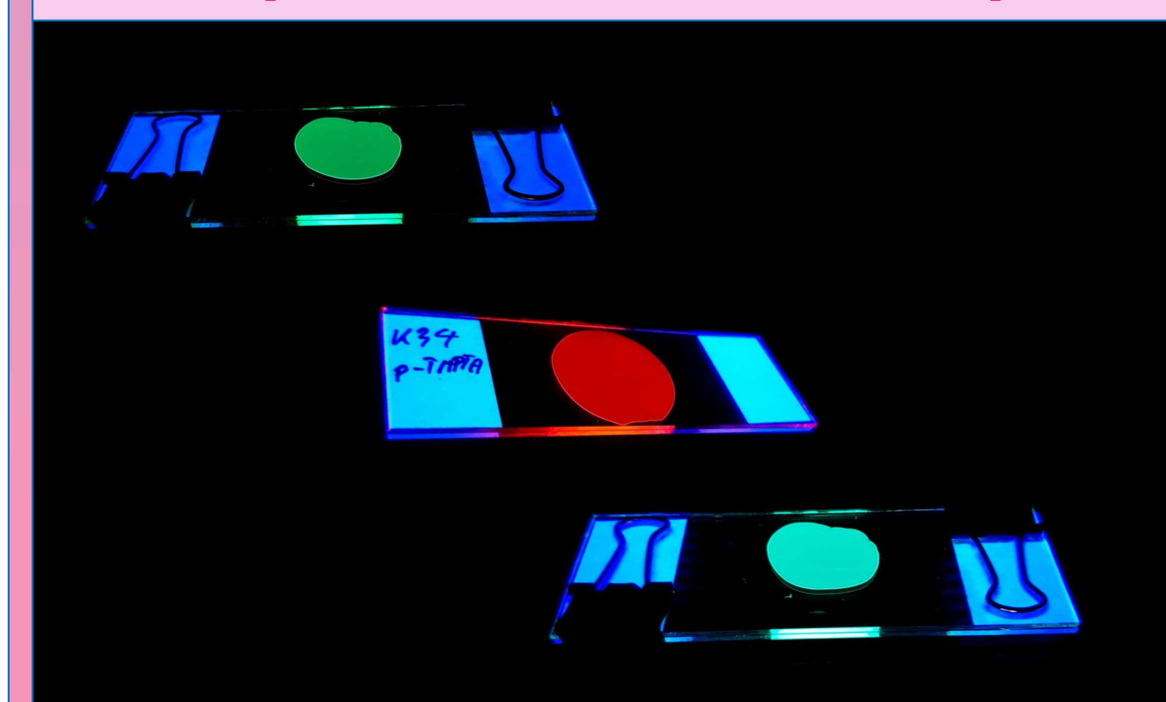
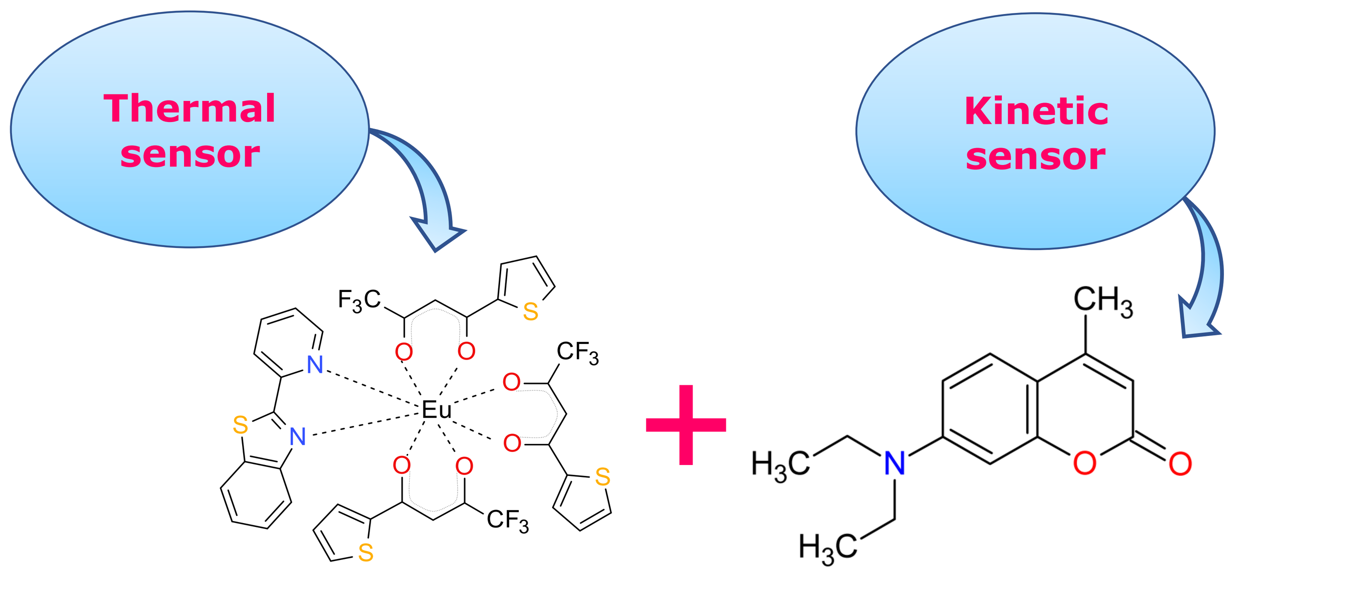


Fig.3. Temperature dependence of normalized luminescence intensity of Eu(TTA)3(PBT) sensor (sensor tested in fully polymerized p-TMPTA coating).

Example measurement samples



Example of sensors used



Eu(TTA)$_3$(PBT) **Coumarin 1**

Advantages of invention

- Enhanced sensitivity and photostability, as well as resistance to environmental fluctuations
- Conducting a controlled polymerization process of the cured coating.
- Reducing the cost and time of measurements
- No need to buy expensive instruments like DSC
- Ability to monitor the process on-line
- Significant improvement of the production process

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