Novel hybrid, high-frequency and ultra-precise luminescent Pressure Sensitive Paints for aerodynamic tests of high-rise buildings and studying the environmental effects of dynamic atmospheric phenomena on buildings and people

Aerodynamic tests of buildings: a new era with fast PSP systems

Aerodynamic tests play a vital role in ensuring wind resistance of buildings, preventing hazards like facade detachment and studying environmental effects on structures and people. Currently used measurement techniques have limited spatial resolution, making it challenging to measure pressures on complex geometries, especially in narrow areas and on the buildings edges. This has created a strong demand for systems capable of precise pressure mapping during aerodynamic tests in wind engineering. While Pressure Sensitive Paints (PSP) hold great potential, their current low sensitivity and long response times make them unsuitable for accurate, high-frequency aerodynamic tests.

This project tackles this issue by developing and testing innovative PSP systems with novel operating mechanisms in a wind tunnel. The goal is to create PSP systems with high sensitivity to pressure changes and short response times, capable of operating within the atmospheric pressure range (±200 hPa). These systems will be tested during high-frequency aerodynamic tests of high-rise buildings and dynamic atmospheric phenomena in the large-scale wind tunnel at the Environmental Aerodynamics Laboratory of Cracow University of Technology (EAL CUT).

The project consists of four key tasks:

1. Developing new PSP systems with innovative mechanisms.
2. Selecting and optimizing the developed PSP systems.
3. Constructing and calibrating a UV-PSP measurement attachment for a large-scale wind tunnel.
4. Conducting high-frequency aerodynamic tests of high-rise buildings, urban complexes and dynamic atmospheric phenomena using newly developed PSP systems.

The project will develop six types of PSP systems: High-Frequency Solvent Quenched PSP, Hybrid Oxygen-Solvent Quenched PSP, Variable-Thickness PSP, Dual-Layer Dual-Solvent Quenched PSP, Emulsion-Solvent Quenched PSP and Micelle-Solvent Quenched PSP. These systems will undergo spectroscopic characterization, pressure calibration and aerodynamic testing.

These advancements will allow simultaneous mapping of pressure distributions in large urban areas, significantly improving the accuracy and spatial resolution of aerodynamic studies. The project will contribute to the development of civil engineering, urban planning and the design of safer, eco-friendly buildings. The implementation of this technology will establish EAL CUT as a leading European facility for aerodynamic testing in wind engineering.