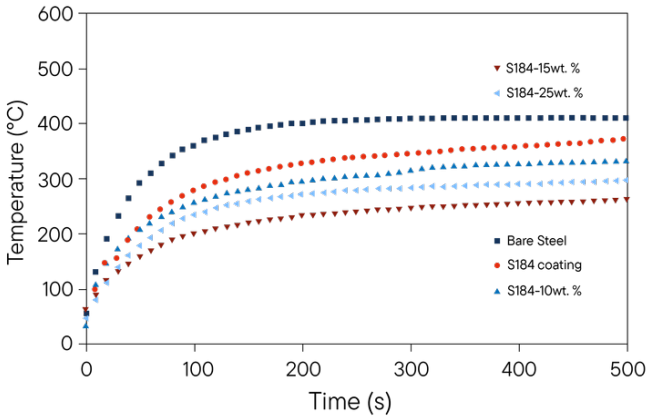
Thermal Barrier Performance of Fire-Resistant Coatings

LFA L52 Analysis of Hybrid Capsule-Based Insulation Systems

The thermal insulation performance of protective coatings plays a critical role in passive fire protection systems. Accurate characterization of heat transfer behavior is essential for evaluating insulation efficiency and improving the thermal resistance of coated structures. In this study, thermal diffusivity measurements were performed using a LINSEIS LFA L52 to investigate the thermal barrier performance of silicone-based coatings containing thermoresponsive $CaCO_3$-SiO_2 hybrid colloidal capsules. The results provide valuable insight into heat transfer reduction and support the development of advanced fire-resistant coating systems.

Measurement Setup

- Instrument: LINSEIS LFA L52
- Material: Coated Steel Substrate
- Temperature Range: Up to 550 °C
- Measurement: Thermal Diffusivity Analysis
- Application: Fire-Resistant Coatings



The thermal barrier test demonstrates a significant reduction in heat transfer through coated steel substrates.

Key observations include:

- Lowest backside temperature at 15 wt.% capsule loading
- More than 30 % improvement in thermal insulation
- Reduced heat transfer compared to reference coating
- Stable thermal barrier performance

The results demonstrate the effectiveness of hybrid capsule technology for enhancing the thermal insulation performance of fire-resistant coatings.

Interpretation

The observed behavior can be attributed to:

- Reduced thermal diffusivity
- Insulating hollow capsule structure
- Slower heat propagation through the coating
- Enhanced thermal barrier effect

This results in:

- Improved fire resistance
- Lower substrate temperatures
- Increased insulation efficiency

Industrial Relevance

Laser Flash Analysis measurements support:

- Fire-resistant coatings
- Structural steel protection
- Building and construction materials
- Thermal insulation technologies
- Passive fire protection systems
- High-temperature protective coatings

Conclusion

The LINSEIS LFA L52 enables precise characterization of thermal transport properties in advanced fire-resistant coating systems. Understanding the thermal barrier behavior of hybrid capsule coatings is essential for optimizing insulation performance and improving fire protection efficiency. These insights support the development of next-generation passive fire protection materials for construction and industrial applications.

Source:
Pham, S. T., Tieu, A. K., Sencadas, V., Joseph, P., Arun, M., Cortie, D.
Thermoresponsive Hybrid Colloidal Capsules as an Inorganic Additive for Fire-Resistant Silicone-Based Coatings.
Industrial & Engineering Chemistry Research, 2022, 61(35), 13104–13116.
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Adapted from thermal diffusivity and thermal barrier performance measurements reported in the original publication. Thermal diffusivity was measured using a LINSEIS LFA 1000 (current designation: LFA L52).