THERMODYNAMIK
Institut für Energie- und Material-Prozesse

UNIVERSITÄT DUISBURG ESSEN
Offen im Denken

Colloquium

within the DFG Project

Phosphorus-containing Flame Retardants on Textiles: Investigation of Structure-Dependent Mechanisms in Fundamental Experiments

Date: November 2, 2026
Room: MA 229

Time	Speaker(s)	Title
11:00	Burak Atakan	Welcome, brief introduction of the chair, context of the DFG project
11:10	Niklas Tomasik / Raphael Otto	Results of the DFG project
11:50	Sebastian Kaiser	Possibilities and Limitations of LIF in Reactive Flows
12:00	Serge Bourbigot (Université de Lille, F)	When Heat Conduction Becomes Fire Protection: Unravelling Intumescence in Polypropylene
12:40	–	Lunch at the cafeteria
13:30	Niklas Tomasik	Lab tour, steady-state experiment
13:50	Sabyasachi Gaan (EMPA, CH)	Flame-Retardant Recyclable Thermosets and Their Mechanisms
14:30	–	Coffee break
14:45	All, discussion	Future Collaborative Research on Flame-Retardant Mechanisms: Which Systems and Experiments Should We Address Next, and How Can We Combine the Complementary Expertise Represented Here?
15:40	Sebastian Kaiser (and team)	Short lab tour (LIF focus)
15:50	Burak Atakan	Summary, possible next steps, informal wrap-up
16:10		End of meeting

Co-organized by Dr. Thomas Mayer-Gall (DTNW, Krefeld) and Prof. Dr. Burak Atakan (UDE)

Guests are welcome!

WHEN HEAT CONDUCTION BECOMES FIRE PROTECTION: UNRAVELLING INTUMESCENCE IN POLYPROPYLENE

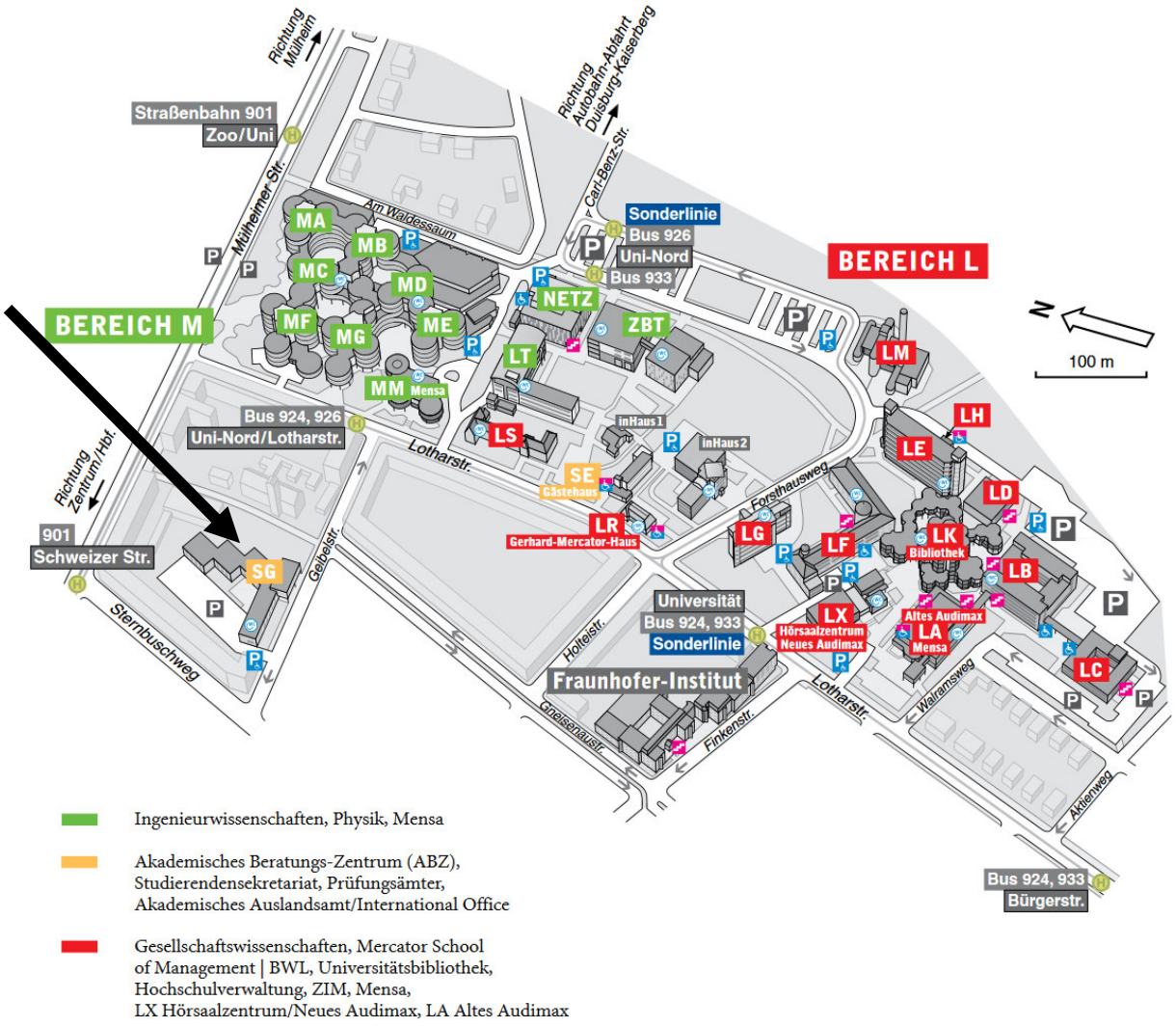
S. Bourbigot[1,2], T. Bensabath[1], J. Sarazin[1]
[1] Univ. Lille, CNRS, INRAE, Centrale Lille, UMR 8207 - UMET - Unité Matériaux et Transformations, 59000 Lille, France
[2] Institut Universitaire de France (IUF), Paris, France
[*] E-mail: serge.bourbigot@centralelille.fr

Intumescence protects polypropylene (PP) by forming an expanded layer during fire exposure. Yet expansion alone does not determine protection: the structure of this layer and its heat-transfer pathways are equally important. This presentation compares physical intumescence induced by expandable graphite (EG) with chemical intumescence produced by modified ammonium polyphosphate (AP), focusing on their mechanisms of action and interactions.

Cone calorimetry at an external heat flux of 35 kW m^{-2}, combined with temperature measurements and X-ray microtomography, shows that incorporating either EG or AP760 at only 10 wt% reduces the peak heat release rate by approximately 70%. Although their fire performance is comparable, their protective mechanisms differ: AP760 forms an insulating carbonaceous layer, whereas EG generates an entangled network of graphite worms that redistributes heat within the expanded structure.

Combining physical and chemical intumescence does not necessarily improve protection. In particular, the formulation containing 9 wt% AP760 and 1 wt% EG exhibits a peak heat release rate reduction of only approximately 30%, together with a rapid initial rise in backside temperature. Morphological observations suggest that graphite worms become preferentially oriented normal to the exposed surface, promoting through-thickness heat transfer rather than lateral heat dissipation. Their incorporation also delays the development of the chemically expanded layer. Further investigations show that these interactions depend on the modified AP grade, graphite expansion characteristics and specimen thickness. Notably, the pronounced initial backside temperature rise observed in 3-mm-thick specimens disappears in 6-mm-thick specimens, highlighting the importance of specimen geometry when interpreting intumescent behaviour. No synergistic effect between AP and EG is demonstrated under the investigated conditions.

A dedicated hot-spot experiment on the graphite-worm residue reveals preferential lateral heat propagation and more limited through-thickness propagation. This anisotropic behaviour explains how thermally conductive graphite can provide thermal protection. Together, these findings demonstrate that effective intumescence depends not simply on expansion, but on the evolving architecture and directional heat-transfer properties of the protective layer.



Lageplan Campus Duisburg

Universität Duisburg-Essen
Geibelstraße 41
Gebäude SG, Raum 055
Campus Duisburg
47057 Duisburg