EXPERIMENTAL CHARACTERIZATION OF PYROLYSIS DURING CABLE FIRES

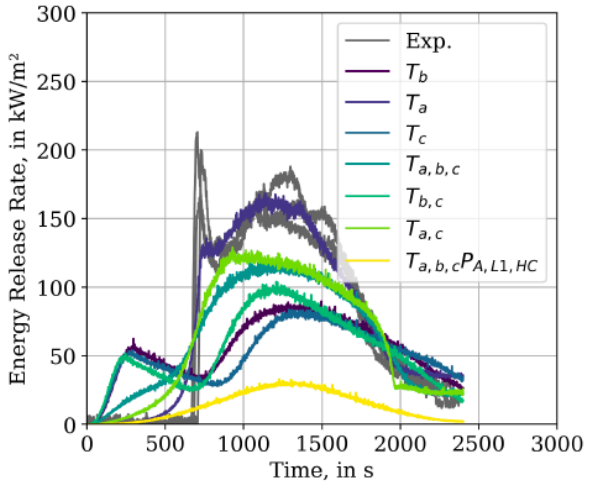
PhD seminar Braunschweig

28/11/2019 I KAREN DE LANNOYE

MOTIVATION

- 5% of home structure fires caused by electrical wire and cable insulation [1]
- Potential source of fire: residential buildings, nuclear powerplants, Aircrafts, spacecrafts,…
- Challenging combined system

- Gap between experimental data and modeling
  - Different boundary conditions
- Spatially and time resolved information



(a) Incident heat flux of 25 kW/m².

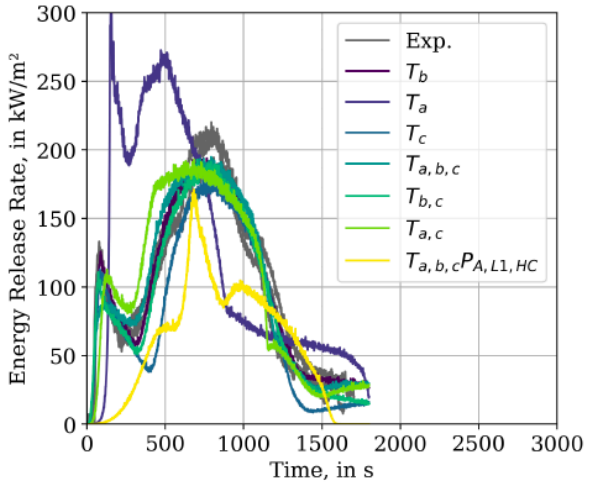


Figure from [2]

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STRUCTURE OF A CABLE

- Polymer insulation
  - PE, PVC, fluorinated ethylene propylene or ethylene tetrafluorpvco-ethylene
  - Flame retardant additives
  - Multiple insulation layers
- Metallic core
  - Strongly influences heat transfer process
  - Joule heating: heat source
  - External heating: heat sink

➔ Strong interaction between insulation and core

- Scaling effect

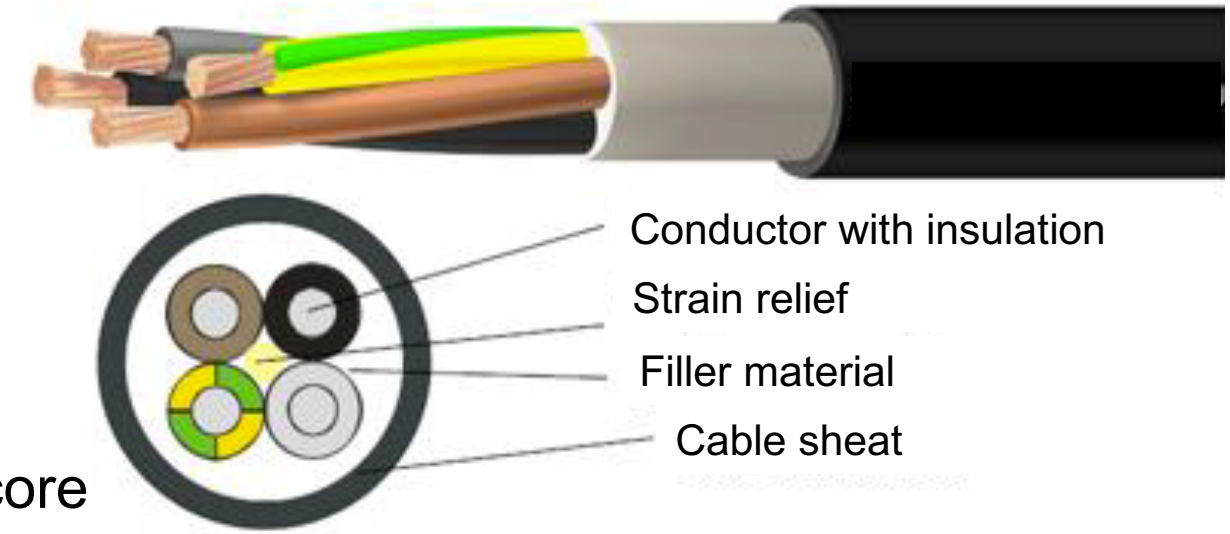
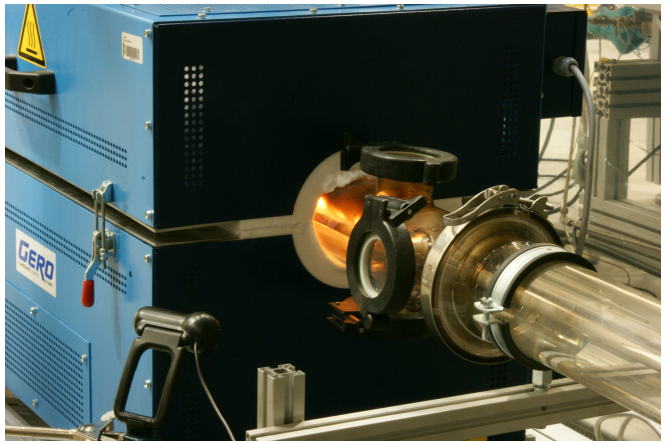


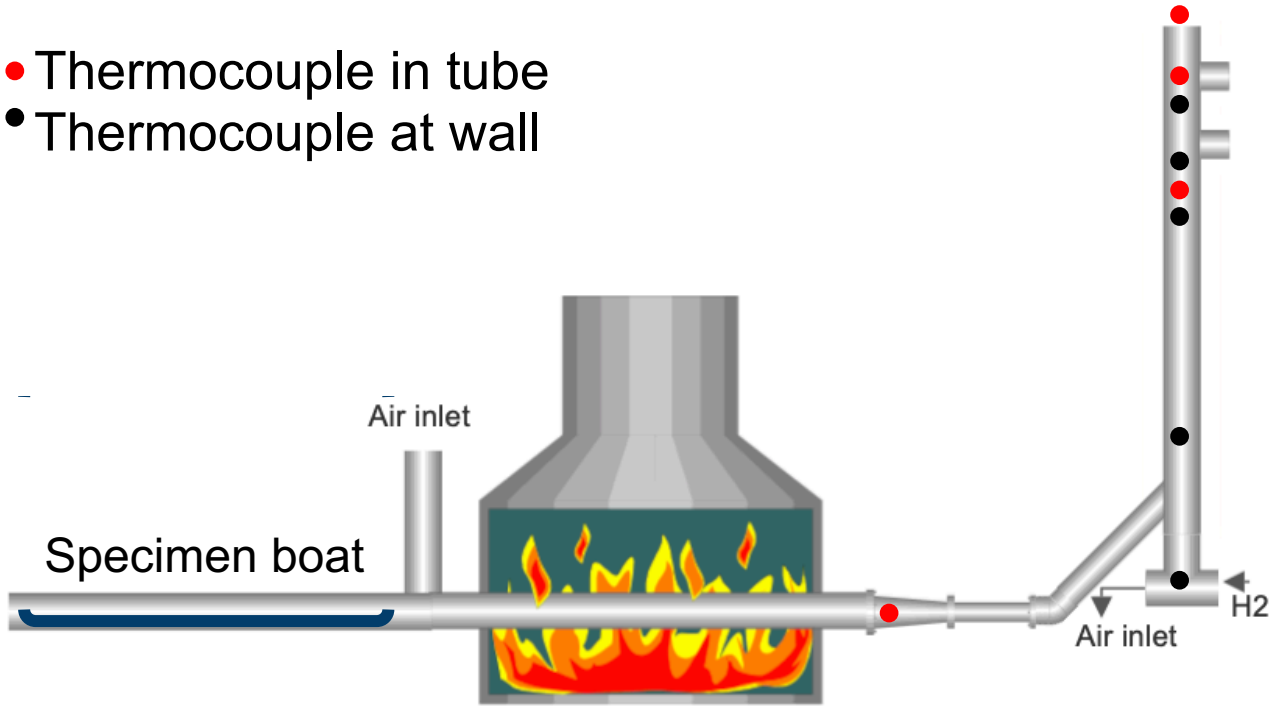
Figure from [3]

Reference: [1,4]

Experimental set-up

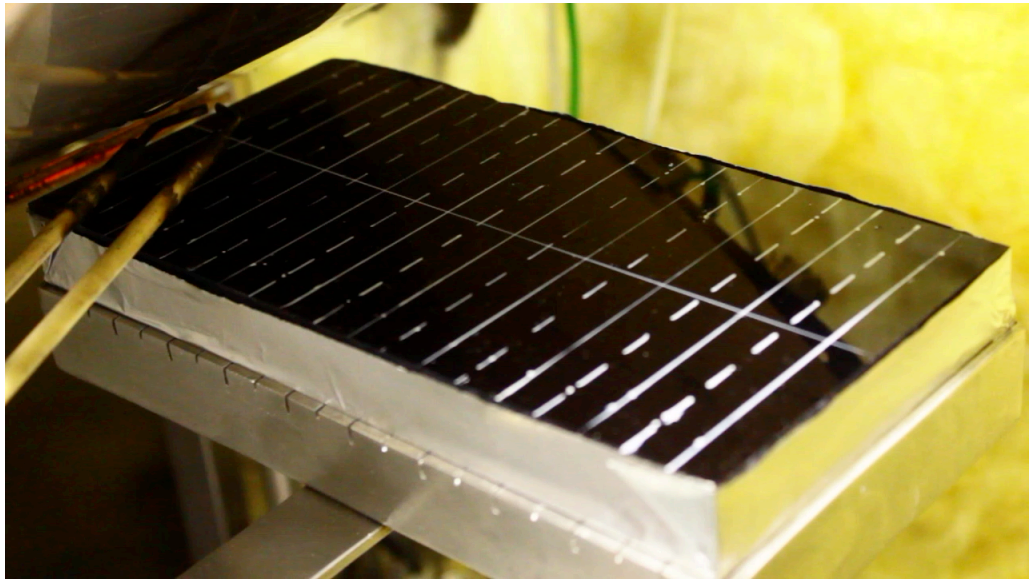
- Quartz glass tube
- Oven:
  - heating rate 300 K/hour
  - Max temperature 1050°C
- Movable specimen boat
- Specimen boat: 80 cm
- Gasanalyzer: CO, CO_2, H_2 and O
- Design balance for weight loss measurements





STEP 1

- Burning PMMA in TGA, cone calorimeter and tube furnace
  - Study scaling effect
  - PMMA easy burning behaviour
    - Decompose almost entirely to monomers
    - Steady burning rate



Movie: private communication with Corinna Tretin

STEP 1

Thermogravimetric analysis	Cone calorimeter	Tube furnace
Mass loss and mass loss rate	Heat release rate determined by oxygen consumption	Mass loss Time and spatially resolved data
Sample size: mg	Sample size: 0.1m x 0.1m	Sample size: 70 cm
Controlled boundary conditions Amount of material Lack of heat feedback	Open ➔ no controlled boundary conditions	Controlled boundary conditions

Reference: [5]

PhD overview

Goal: conducting experiments to improve general understanding of cable fires and have additional for modeling and CFD methods

0-3 months (currently)	Literature research, Participating in and data analyzes of cathalyzator experiments
3-5 months	Setting up tube furnace model with FDS Designing balance for tube furnace
5-8 months	Experiments in TGA, Cone calorimeter and tube furnace with PMMA
5-6 months	Determining which cables to study
7-12 months	Studying and implementing possible improvements to the experimental set-up
10 months – 3 years	Conducting experiments
2,5 – 3 years	Writing

REFERENCES

[1] Huang, X. & Nakamura, Y. (2019). A Review of Fundamental Combustion Phenomena in Wire Fires. *Fire technology 2019*. Retrieved from: https://doi.org/10.1007/s10694-019-00918-5

[2] Hehnen T et al., Numerical Fire Spread Simulation in CHRISTIFRE Phase 1 Cable Tray Installation Based on Material Pyrolysis, in progress.

[3] Kubelt, C. M. *Ablagerungsverhalten von Kernschmelz- und Brandaerosolen in einem DWR-Sicherheitsbehälter (doctoral dissertation).*

[4] Matala, A. (2013). *Methods and applications of pyrolysis modelling for polymeric materials (doctoral dissertation).* (VTT science 44).

[5] Hurley, M. J. (2016). *Sfpe handbook of fire protection engineering*. New York, NY: Springer.