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Design of novel non-halogenated flame retardants – combustion and polymer scientists join forces

Carl-Eric Wilén, Åbo Akademi University, Laboratory of Polymer Technology, Biskopsgatan 8, 20500 Åbo
Mikko Hupa, Åbo Akademi University, Process Chemistry Centre, Biskopsgatan 8, 20500 Åbo

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Project title: Design of novel non-halogenated flame retardants – combustion and polymer scientists join forces

Responsible project leader: Professor Carl-Eric Wilén

Resources:

Laboratory of Polymer Technology, Åbo Akademi University
M.Sc. Melanie Aubert
M.Sc. Weronika Pawelec
M.Sc. Teija Tirri
Prof. Carl-Eric Wilén

Process Chemistry Centre, Åbo Akademi University
M.Sc. Johan Lindholm,
Dr. Anders Brink,
Prof. Mikko Hupa

Updated research aims:
Our intent is to develop jointly further the family of novel azoalkane fire-retardants and above all to create a base for constructing a novel tool-box that will be helpful in rendering any polymeric material fire retardant. Our approach will be based on synthesis of novel model flame retardant compounds, new fire test methodologies, new techniques for evaluating results, including mathematical modeling and simulation that will further increase our knowledge in fire retardancy theory and applications.

Results (publications, patents, conferences, etc.)

Publications:

1. Aubert, Melanie; Weronica Pawelec, Roth, Michael; Pfaendner, Rudolf; Wilen, Carl-Eric " Azoalkanes – novel flame retardants and their property relationship" *Polymers for Advanced Technologies*, (in press)
2. Aubert, Melanie; Roth, Michael; Pfaendner, Rudolf; Wilen Carl-Eric, "Bis(1-propyloxy-2,2,6,6-tetramethylpiperidin-4-yl)-diazene – an innovative multifunctional radical generator providing flame retardancy to polypropylene even after extended artificial weathering" selected for publication in special flame retardant issue of *Polymer Stabilization and degradation*.

Patents:

Simon Kniesel; Holger Hoppe, Pfaendner, Rudolf; Wilen, Carl-Eric; Aubert, Melanie, Weronica Pawelec, " New flame retardant", invention disclosure has been filed"

Conferences:

1. Mélanie Aubert, Weronika Pawelec Rudolf Pfaendner and Holger Hoppe and Carl-Eric Wilén[1]* **Multifunctional flame retardants based on azoalkanes,** oral presentation at the 12th European Meeting on Flame Retardant polymers, Poznan University, Poland.

Impact of research activities (visits, interviews, other activities)

Collaboration with professor Vuorinen group at Tampere University of Technology within the framework of FIRECO and novel flame retardants for thermoset polymers has been initiated.

New collaboration with professor Seppo Syrjälä concerning the use of azoalkanes in biopolymer applications.

Interest of companies towards the research project:

Numerous domestic and international companies have shown interest towards the flame retardant research project. Among other things, with Kiilto Oy new environmentally friendly flame retardants for polyurethane based glues has been developed and in collaboration with BASF new flame retardants for polyolefins are under development.

Research progress in regard to original plan:

The research has progressed according to aims set forth in the original research plan. Thus, we have successfully prepared new flame retardant compounds and gained a better understanding of structure property relationship of azoalkanes and their efficacy as flame retardants.

In 2009 inorganic flame retardants have been investigated. These can be divided into two groups. One group consists of salt mixtures having a low eutectic melting point. These act as a barrier for heat transfer and mass transfer. It was found that such salts can be successfully used, but finding salt mixtures with a low eutectic melting temperature not containing chlorine seems challenging. The other group consists of hydrates. These have in common that when heated they release H2O. The decomposition is endothermic, i.e., it requires energy. As a result, these compounds slow down the heating of the combustible material. The released H2O also act as a mass transfer resistance due to the Stefan flow effect on diffusion rate. Mixing several of these compounds it is possible to design a tailor-made flame retardant.

Also down scaling of the sample size to be used in the cone calorimeter has been studied. Down sizing the sample from 10x10 cm to e.g. 2.5x2.5cm is advantageous during the screening process of new lab synthesizes flame retardants, as the scale-up of synthesizes of large quantities can be very time consuming.