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Topic of the Speech:

Strategies for Flame Retardant Textiles

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Education and training: 1996 EURING professional title obtained from FEANI Paris, 1995 Academician of the Ukraine Academy of Engineering Sciences, 1993 University professor degree in the field of textile engineering, 1991 Associate professor, regularly habilitated in the field of textile technique, 1982 Ph.D. degree concerning of the properties of the modified polyester fibers, 1973 Engineer degree, graduated with honor at Textile Faculty.

Work experience: 2013 - 2016 Head of Department of Material Engineering, 2009 – 2012 Vice dean for foreign affairs, 2003-2008 Dean of Textile Faculty, 2000 - 2002 Vice rector for science and foreign affairs at TU Liberec, 1994 - 1999 Dean of Textile Faculty, 1991- 1993 Vice rector for foreign affairs at TU Liberec, 1991 – 2012 head of Department of textile materials, 1976 - 1989 Research Institute of Textile Finishing, head of scientific development dept., 1973- 1976 State Textile Research Institute Liberec – research worker.

Specialization: Research in the field of modeling of properties of fibers and textile structures. Research in the area of textile material engineering, metrology, and applied statistics. Main activities and responsibilities: He started to work in the field of the modeling of the kinetic processes in solid phase. In this field he published about 30 scientific papers. He was engaged in State Textile Research Institute in the department of the mathematical modeling of the textile structures from 1973 to 1976. He started with research in the field of statistical data analysis and quality control here. On these themes he published 4 books and about 100 scientific papers. From 1976 to 1989 he was engaged in Research Institute of Textile Finishing in Dvůr Králové, in many positions, from head of the research department till scientific secretary. Here he worked in the field of textile dyeing, physics of the fibers, mathematical modeling in textile branch and control of dyeing and drying processes. In collaboration with University Pardubice he is working in the field of chemometric in analytical laboratories. The two volume monographs published in England was finished in 1994 and 1996. In 1982 he defended Ph.D. degree concerning of the properties of the modified polyester fibers. Since 1989 he is at the Technical University of LIBEREC (TUL). He is responsible for lectures in TUL at the Department of Textile Materials (textile fibers, textile testing. quality control, mathematical modeling, data treatment).

Awards and membership in scientific societies: 1999 - 2010 head of Czech Section of „The Textile Institute“ Manchester, 1999 - G.H. Smith award of The Textile Institute Manchester, 1997 - 2004 board member of Czech Statistical Society, 1994 - board member of Czech Chemometrical Society, 1996 - board member of International Textile Academy, 1995 - president of Czech Monitoring Committee of FEANI, 2006- member of the Czech Engineering Academy.

Publication activities: 26 books, 481 articles, H index (SCOPUS) 31

ABSTRACT SUBMISSION
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Strategies for Flame Retardant Textiles

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ABSTRACT

According to statistics, around 3,000 people die each year as a result of fires. Most of these deaths are caused by smoke inhalation, not burns as the primary cause of the injuries. The number of injuries from fire events is around 16,000 annually. Injuries include burns (1st, 2nd, and 3rd degree), respiratory injuries etc. One of most important materials responsible for fire spreading, smoke generation and burn injuries are textile structures. Textiles are generally highly flammable materials (with a few exceptions), not only due to the chemical composition of the fiber-forming polymers, but also due to the specific macro structure of the textiles. This study is focused on the physico-chemical processes of flame generation and spread, combustion mechanisms, flame retardancy strategies and influence of temperature generated by flame on production of burn injuries.
Flame propagation in real conditions is combination of all heat transfer mechanisms. The flame can be spread to other places only if the temperature of this place has exceeded a certain value. The simple hypothesis is that the heating occurs mainly by the action of infrared radiation produced by the flame. A normal flame emits radiation at wavelengths of 1-10 micrometers with a maximum of about 2.5 micrometers, while the amount of radiation below 2 micrometers is very small. The results of measurements in the near-infrared region show that polymers behave similarly in this region. The absorption of IR radiation can also be used to assess the possibility of influencing the flammability of textiles by changing the absorption of IR radiation by metals plating (reducing the absorption of IR radiation) or by applying carbon structures (increasing the absorption of IR radiation). Combustion generally needs three components: flammable material, sufficient thermal energy and enough concentration of oxygen. Only the flammable gases (products of pyrolysis) are capable to burn. Polymers containing higher amount of hydrogen bonds (cellulose) are easily flammable. Less flammable are polymers containing aromatic rings or halogen groups. Processes of polymeric materials fire are combinations of heat and mass transfer/diffusion, fluid dynamics and degradation chemistry. The major flame retardation principles are reduction of the heat required to sustain combustion, modification of pyrolysis to reduce flammable volatiles, dilution of volatiles by non-flammable gases, promotion of char formation, preventing of oxygen access, increasing the ignition temperature of the volatiles, reduction of heat flow to polymer, restriction of fibers decomposition by increasing of their temperature resistance, support of fibers dripping during melting (fiber is separated from combustion zone) and creation of thick insulating porous layer on the fiber surface. Advantages and limitations of these principles will be comprehensively discussed. The basic groups of flame retardants and their mechanisms will be specified. Beside classical flame retardants the recent nanotechnology-based materials to promote flame retardancy will be presented. Results of flame propagation through high loft nonwovens composed from different inherent flame-retardant fibers will be compared. Prediction of skin temperature and simple burn models used for quantification of thermal exposure and human cells injury will be also shown.