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**Research area: Product aims**

Paper, paperboard and board // technical speciality papers

**Key words:**

Fire resistant coating, nacre, protective coating

**TITLE:**

## Self-assembly of large-scale nacre mimetic hybrid films

### Background/Problem area

A flame retardant finishing of surfaces is essential to prevent fires and limit the damage of person and property. A wide variety of flame retardant coatings exists, but their components may contain heavy metals, or may release toxic gases formed by halogen compounds during the combustion process. The flame retardant sector is currently undergoing a radical change, since current agents are ecologically unsound and must be replaced by non-toxic materials in the future. Particular challenging is the development of safe, cost-effective alternatives, which can be applied easily. The development of environmentally friendly flame barrier layers which prevent a complete penetration of flames and enable a thermal insulation of the materials behind the protective layer provides a wide variety of applications. An ecologically promising approach arises from the construction of films of a regular silicate/polymer multilayer system. The established ways to build such layers are not eligible to be used in paper applications for economic reasons as well as due to poor mechanical stability and optical transparency. Using so-called nacre mimetics enables for the first time the creation of core-shell layered silicate platelets with polymer binders immobilized on the inorganic component via self-assembly, using specific polymer/silicate interactions. The arrangement of components to "brick and mortar" structure as generally found in biogenic mollusc shells occurs at ambient conditions and allows the production of thin coatings in continuous roll-to-roll manufacturing processes.

### Objectives/Research results

The project is aimed at the development of a well-adhering, flexible and environmentally friendly intumescent flame and heat barrier coating for paper products. Polymer-coated layered silicates shall be produced which can be organized from an aqueous dispersion to a nacre-analog brickwork forming a porous ceramic material during combustion protecting the substrate from fire/heat exposure. Polymer/layered silicate dispersions exhibiting high solids content shall be prepared in this context. The dispersions are composed of a polymer which enables the production of a flexible coating in combination with an appropriate silicate. A further aspect which is where focus is set on is to ensure the printability of the flame-retardant material by an additional multi-layer coating without affecting the intumescence level. As a first step, suitable base paper substrates were screened and selected according to the criteria dimensional stability and coating adhesion. Secondly, polymer-/layered silicate dispersions were produced with focus on workability of the produced coating colors. As inorganic components, several commercially available silicates were investigated. For the polymeric part of the dispersions different binders, typically used for coating colors were used and investigated. The solids content and the viscosity of the coating colours produced, was found to be strongly dependent on the pigment used. Maximum solids contents in the range of approx. 20% were achieved using mixtures of Kaolin and Nanoclay. The dispersions with varying polymer content were applied to the paper and resulted in homogeneous coatings. The coated samples were characterized by various methods, including scanning electron micrographs of surface and cross section. The micrographs showed a good orientation of the pigment platelets on the surface of the paper. The flammability of the pre-coated base paper could be significantly reduced in many cases using coat weights of approximately 10 g/m2 per side. The printability with offset printers could be drastically improved, applying an additional top-coating, without affecting the fire retardant properties.

### Application/Economic benefits

So far no method exits for the production of comparable coatings showing similar multifunctional material properties (light construction, mechanical stability, low gas permeability, high transparency) together with economically and ecologically sound produced flame barrier layers. The combination of manufacturing and material properties makes the newly developed material particularly attractive and competitive in comparison to other established materials. The development of cost effective, innovative, ecologically sound flame barrier materials serves to a global, rapidly growing market in the paper sector where not only the prevention of damages by fire, but also the reduction of insurance premiums creates additional motivation for the use of new products. The combination of bio-inspiration (nacre) and environmentally friendly method offers additional image advantages for SMEs involved in the marketing of fire preventing products. In addition to the end user, companies from a variety of industries in the value chain – in the sectors fibre and additive manufacturing, machine construction or coating of of paper-based products – may profit. These SMEs benefit by expanding of their product portfolio, thereby strengthening the market position in the (inter)national competition.

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