Focke: Ongoing and Planned Future Research

Chemical and polymer technology

Carbon technology

Current work is focused on the preparation of modified expandable graphite materials for direct use as functional polymer additives and as precursor for graphite nanoplatelets. The focus remains on improving polyolefin flame retardance [1] and thermal conductivity, e.g. in thermal energy storage materials.

Clay and polymer additive technology

Volatile corrosion inhibitors. I plan to explore the possibility of developing volatile corrosion inhibitors that are fully biodegradable and derived from renewable resources.

Synthesis and modification of clays for polymer nanocomposites. The objective will shift to employing nanoclays as permeability modifiers in controlled release applications targeted toward the malaria vector control products. We also intend to use them in micro-encapsulated repellents for push-pull pest control in agriculture [2].

Malaria vector control. It is my intention to intensify my focus on malaria vector applications. We want to use our expertise in chemical and polymer technology to develop products that will contribute to the elimination of malaria. In particular, we hope to focus on protecting people outdoors against malaria transmission. Current projects include the development of better topical repellents, repellent textiles based on bicomponent fibre technology [3] and the long lasting repellent bangles and anklets based on microporous polymer technology [4]. We have already secured funding for some of these projects.

Pyrotechnics

We have, for all practical purposes, achieved our first goal, i.e. the development of “green” pyrotechnic compositions for use as time delays and initiating compositions in chemical mine detonators. Our vision for the future is to contribute to the development of “on-demand on-site” technology for the manufacture of detonators. Today, bulk explosive is very safe to transport and apply as it is only sensitized just before it is filled into the blast holes. However, detonators are very dangerous because they contain very sensitive primary explosives. Hence they need special transport and safe handling procedures. Our vision of the future is the manufacture of the required initiating systems on site at the quarry or mine using printing, and in particular 3-D printing technology. We anticipate that the timing function will be provided by inkjet-printed circuitry on a suitable substrate, perhaps a polymer sheet. The amplification of the initiation impulse will need 3-D printing and we believe that could be possible using fluoropolymer-based thermite formulations. Thermite formulations tend to be insensitive to ignition (which makes them safer to use!) and also tend to be slow burning. Obviously, the proposed idea requires very fast burning and the ability to initiate a high explosive (e.g. PETN) booster. This may require the incorporation of nanoscale or nanostructured fuel particles in the polymeric oxidant. We are in the process to set up laboratory facilities and to licence a laboratory that will enable us to pursue this vision. This includes the ability to synthesize special fluoropolymers, to compound filled energetic polymer, to extrude them into filaments for 3-D printing using fused deposition modelling (FDM). In the mean time we have started to work on proxy systems and on

methods to make high surface-area fuel powders. The first paper on fluoropolymer system has been published [5]. We have already achieved extremely fast burn rates and this work was presented at a recent congress [6].

References

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