

Carbon companies, such as Blucher,
are working on more adsorbent
carbon, like Schmitt 4 ©Blucher

Challenging times

GW: I'd like to focus on some of the next-generation suits and technology that you are working on...

EW: Looking back at the article we did in 2007 (*CBRNe World* Spring 2007) I came to realise that science moves at a certain pace, and new developments take time, but I think there are some recent developments on several fronts that are quite exciting and that have the potential to transition to the next generation of protective ensembles.

GW: Well, something new you have been doing is putting the Alexium fabric (Alexium bonds various catalysts to shell fabric) through its paces with some testing. How did you come to be involved? What benefits does that technology offer over things like the Joint Service Lightweight Integrated Suit Technology (JSLIST – the in-service product)?

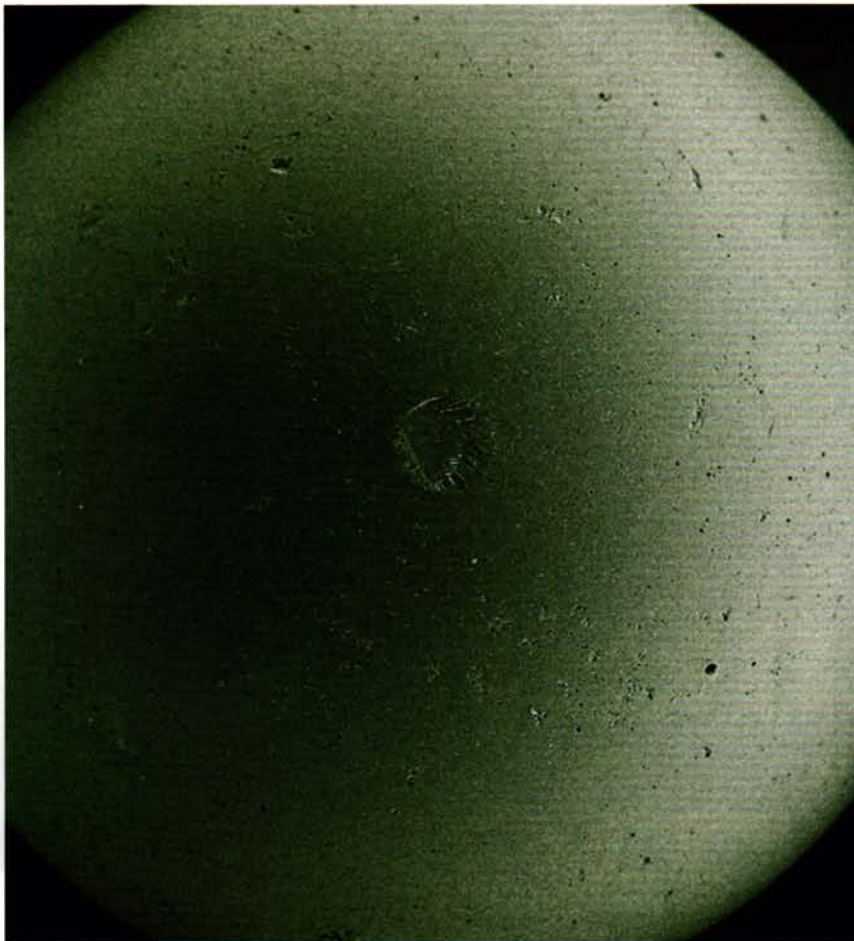
EW: We are involved in looking at that technology. This approach involves the use of n-halamines bonded to outer shell fabric. We have had some pretty good luck with that type of finish on fabric in terms of its antimicrobial properties, and also some positive results where the material acts as a catalyst in detoxifying at least one type of hazardous chemical to a certain degree. So we are moving along and looking at that technology as an enhancement for next-generation chemical protective clothing.

GW: Another technology that has emerged is GE's "Event" ePTFE active film. When you take Alexium and Event together, they suggest membrane technology is far closer to fruition than it was when we did the last interview. Could it be time for them to keep their promise?

EW: We have done a lot more work on the ePTFE type of materials. These materials are commercially available right now, and they can be incorporated into textile systems quite readily. These can provide some enhancement in chemical protection. You can have a membrane material like an ePTFE membrane incorporated in the textile system, and you can also have within, or on, the outer shell fabric the halamine technology, or some other self-detoxifying treatment, as an added property to future garments. At the same time we are trying to reduce the weight of chemical protective clothing systems, so we have to carefully balance – as we discussed last time – the weight and protection versus thermal comfort.

GW: Are we seeing any developments in the testing regime? During next-generation trials in the UK, using DSTL's new particle counting system,

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Neither planet nor pudding, but a spherical high performance adsorbent ©Blucher

they were able to more accurately measure the protection factor – and they suddenly realised the protection factor on the existing respirator was far higher than they had previously thought. Is it the same for suits and ensemble? You get the moveable or sweating mannequin, but rarely do you get all the requirements you would want for the wind and vapour challenges to accurately work out the protection factor. Because you don't know the factor accurately, do you build increased protection in and increase the physiological load?

EW: All countries have been very careful about ensuring they have sufficient protection – therefore it is possible garments may have been over-engineered to ensure that they provide it. You can now get a lot of information using articulated mannequins for vapour testing and also thermal

mannequins; several countries now have these testing capabilities. These mannequin tests are very useful for screening purposes during the development of new ensembles. You can also do the vapour testing with human subjects, as long as you use non-toxic simulants such as methyl salicylate. You can also do physiological tests in climatic chambers. You can now get much more reliable information about the specific physiological load a garment imparts, and about its chemical protective capabilities, with a human wearing a garment in a chamber, even if chemical testing is done with a simulant. A person can perform a set of movements that are realistic and which flex the garment the way it might be flexed in normal use, which produces much more reliable information than we got in previous years. The next step in

evolving vapour systems testing is likely to be the introduction of real-time vapour samplers. Several countries are working on developing these types of samplers.

GW: Can you take that data and show it to the user community, who set the challenge levels, and say if they can be more specific with the type and amount of agents they are worried about you can do some snazzy things or, if nothing else, you can reduce the carbon to lower the burden? Have you had any luck taking the data to the users and getting them to free your hands?

EW: The user community is aware of the testing that's been done. If the user community is willing to accept a lower challenge level than it has in the past, or a shorter protection time, then it's possible to fabricate garments that are lighter weight and which impart less thermal burden to the wearer.

GW: In Europe, people like Mast Carbon and Saratoga/Blucher are working on next-generation carbon. Can you see it continuing to the extent that carbon becomes more effective at the lower levels, and that you will always have carbon layers in our suits? Or will it eventually be surpassed no matter how much better it gets?

EW: At the moment it looks like there is plenty of room for carbon technology for years to come – but there is also room for the membrane technology. There is certainly R&D work going on to improve the surface area of carbon particles; if you can do this then theoretically you can use less carbon, still have the same or even better adsorption capacity, and produce a lighter weight garment. There is a lot of work being done to develop carbon fibres, where the fibres themselves are carbonised and the fabrics are built out of carbon fibres – so instead of a lining of carbon particles you can have a lining of carbon fabric. There is a great deal of work ongoing, especially in academia, in developing novel adsorbents which are candidates for respirator canisters for use in conjunction with carbon. There are many novel adsorbents with high surface areas that are being produced that need to be tested a lot more, but it is relatively

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easy for chemists in academia and industry to fabricate these novel materials. We could see carbon enhanced, or complemented, with some novel adsorbents like metal organic frameworks (MOFs), and other materials from the field of reticular chemistry. I think there is plenty of room for advanced carbon technology, advanced adsorbents, and membranes.

GW: We have looked previously at single-walled carbon nano tubes (CBRNe World Winter 2008), which seem to be the coming thing for blast and kinetic protection. I was wondering whether you had evaluated them much for chemical and biological protection?

EW: They are certainly interesting materials and people continue to develop them. Some people have looked at ways of attaching a catalyst to the carbon nanotubes, but I haven't seen real developments that are approaching the application stage for chemical protective clothing – they are still relatively expensive materials as they are novel. As the cost comes down there may be some point in considering them, but right now it seems we need further developments in that area before they are seriously considered for chemical and biological protection.

GW: What would you would mark as "one to watch" – something that will come to fruition within the next four years?

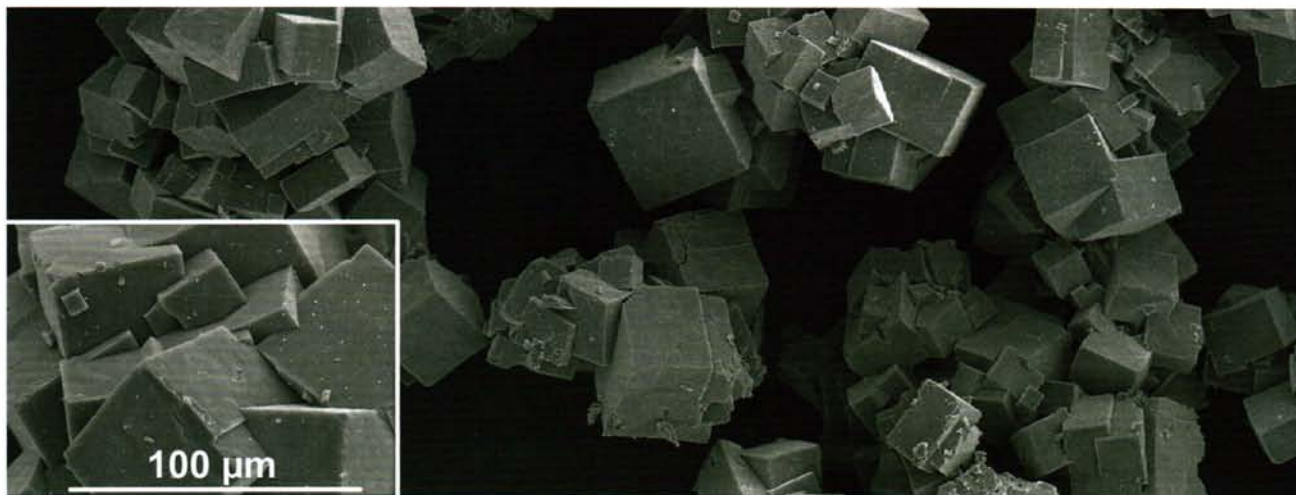
EW: MOFs and the other advanced adsorbents are likely to find their way into respirator canisters and perhaps into carbon-based clothing systems. There is a lot going on in the respirator technology area, such as conformal filters that have low-profile shapes which helps the integration of respirators with helmets. There is also work going on with dual-seal respirators – where the respirator has an inner oral/nasal mask or cavity within the outer respirator piece. That particular design has a lot of potential for improved protection. Again in respirators, we have materials technology work going on in the development of composite materials – flexible barrier materials which could be a substitute for silicone for the main body of the mask material.

There is a lot of work being done in academia on catalysts, so we are going to see more catalysts being introduced into clothing systems for the purpose of developing self-detoxifying clothing. Some of these have been around for a long time like enzymes, but new catalysts have been developed as well. Polyoxometallates (POMs) have a lot of interesting characteristics when it comes to reactions with hazardous chemicals and their detoxification. These catalysts can be synthesized in many different formulations, and therefore have a lot of potential. Oximes and porphyrins are two other types of

catalysts that have been shown to be effective against certain hazardous chemicals. There are some interesting organic dyes that generate a reactive form of oxygen, called "singlet oxygen." This singlet oxygen also has the potential to catalyze the destruction of certain chemicals. We are also interested in longer-range approaches; we are interested in intelligent textiles which change their permeability in response to stimuli like temperature or relative humidity and become more permeable under one set of conditions and less under another. We are also looking at aspects of electronic textiles, for example, work which is ongoing in fibres in embedding electronics within the core of the fibres, which leads to all sorts of potential in regard to the incorporation of chemical sensors within fabrics. We are also interested in personal cooling fabrics, where technology such as thermoelectrics could be used to provide cooling in a lightweight fabric, thus eliminating the need for vests which circulate cooling water.

GW: The dyes are a new one for me. How do they work?

EW: Some organic dyes have been identified that, upon exposure to UV light, generate singlet oxygen, a short-lived species, which has been shown to have the potential to detoxify hazardous chemicals.



MOFs, and other novel adsorbents, are becoming a reality ©Max Planck