Intelligent Textiles for Chemical Biological Protective Clothing

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For many years chemical biological (CB) protective clothing used by the military has relied on activated carbon as an integral component of the textile system. The carbon does an excellent job as an adsorbent for hazardous chemicals. In an effort to develop CB clothing which is lighter weight, more comfortable, and mission friendly, materials research has been ongoing to reduce the quantity of carbon used or even eliminate it altogether. During the past several years membranes have been developed that have the potential to form the basis of the next generation of protective clothing. Membranes for this purpose can be of two types – microporous or nonporous. Microporous membranes can be used in conjunction with a carbon layer. Nonporous membranes can be used without any carbon or with a minimal amount. Among the many challenges is the need for the membrane to serve as a barrier to hazardous chemicals while still allowing a significant degree of moisture vapor transport. It is essential that the permselectivity of the membrane be optimized. Several approaches to this optimization have been examined, and two are particularly promising. Ion implantation has been used. In addition, monolayers and bilayers of cyclic molecules of controlled pore size have been applied to the surface to regulate diffusion into the membrane. Both techniques have led to prototype membranes with improved permselectivities. Ensembles fabricated from nonporous membranes face the issue of being susceptible to compromise at the interfaces in the clothing system because of pumping action. Carefully designed closure systems are needed to overcome this concern. Research is also underway to develop filter fabrics and to incorporate catalytsts and antimicrobial treatments into these textile systems eventually leading to self-detoxifying CB protective clothing. Additional research is focusing on developing fabrics with controllable, variable permeability. Such fabrics will ideally respond to an external stimulus, act as a barrier in the presence of a threat, and otherwise serve as a breathable and comfortable fabric. Chemical and biological sensors are being developed for incorporation into CB fabrics. Personal cooling fabrics are also being developed.