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Cross-linked Lyotropic Liquid Crystal–Butyl Rubber Composites: Promising "Breathable" Barrier Materials for Chemical Agent Protection Applications

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Poster Session session

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Abstract
Cross-linked butyl rubber (BR) is a low cost but highly effective protective clothing material that is used in industry and in the military to protect the wearer against exposure to a variety of hazardous chemical substances. One of the major drawbacks of BR protective clothing is that it causes severe heat stress in the wearer with prolonged use. Cross-linked BR has low permeability towards air and water vapor, thus preventing moisture vapor from escaping (an important cooling mechanism). What is desired in an advanced protective garment material is the ability to selectively block toxic substances while letting air and water vapor through; and/or the ability to destroy these substances on contact. Herein, we describe a method for generating nanoporous, "breathable" BR nanocomposites by blending and copolymerizing BR with a cross-linkable lyotropic liquid crystal (LLC) monomer (1). Amphiphilic monomer 1 self-organizes into an inverted hexagonal (HII) LLC mesophase (i.e., a closed-packed ensemble of inverted cylindrical micelles) with a monodisperse aqueous pore diameter of ca. 1.2 nm. By cross-linking 1 with BR, polymer nanocomposites were obtained that retain much of the high chemical resistance of BR but allow water vapor transport due to the imbedded nanoporous LLC structure These nanopores provide very small, discreet hydrophilic pathways for water transport with only a slight compromise in chemical agent rejection due to the low water solubility of chemical warfare agents at ambient temperature. This presentation describes the blending, LLC phase formation, and polymerization behavior of these novel LLC-BR networks. Preliminary permeation studies with water vapor and 1-chloroethyl ethyl sulfide (CEES, a mustard agent simulant), show that the materials still reject CEES to a large degree but allow good water vapor permeation with excellent selectivity.