PROTECTION - SCIENCE AND TECHNOLOGY ADVANCES FOR CHEMICAL AND BIOLOGICAL PROTECTION

Elastomer Laminates For Chemical Protection

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Many different types of elastomers are used in personal protective equipment (PPE) for protection from chemical hazards. Typically, PPE contains a single elastomer type selected for specific resistance to a known chemical class. However, this single elastomer type may provide insufficient protection from other classes of chemicals. Instead of changing to a different elastomer based PPE, this limitation can be addressed through the use of multi-layer elastomeric laminates to take advantage of the resistance properties of each individual layer. In this study, good adhesion between layers and acceptable permeation resistance were sought without making the laminate thicker (heavier) than a single layer PPE elastomer. A tri-layer laminate consisting of bromobutyl rubber (BIIR), acrylonitrile-butadiene rubber (NBR), and fluoroelastomer (FKM) was successfully fabricated through compression molding. The adhesion in BIIR-NBR-FKM was improved simply by adjusting the rubber formulations rather than the higher cost route through surface treatments or applying additional transition layers. The effects of magnesium oxide (MgO), zinc oxide (ZnO), stearic acid (SA), carbon black, and phosphonium salt on the vulcanization and adhesion of the BIIR-NBR-FKM laminate were systematically investigated through a rubber process analyzer (RPA) and the T-peel test. The resultant formulations yielded optimized dynamic cure behavior and adhesion. The influence of phosphonium salt on the curing of NBR and its adhesion to FKM was also studied with the results indicating that only a combination of phosphonium salt with a proper accelerator was able to achieve sufficient curing of NBR and robust adhesion between NBR and FKM. The chemical resistance of the laminates was determined using the ASTM F739 method with three challenge chemicals: 2-butanone (MEK), toluene, and butylamine. Breakthrough times, permeation rates, and steady-state permeation (where possible) were recorded. Some breakthrough times of the laminate were observed to exceed the breakthrough times of any of the individual elastomers at approximately the same total thickness. Further discussion of the adhesion strength and permeation behavior of the laminates will be presented.