Nanocomposites for Military Food Packaging

Innovative research between the NSRDEC and their collaborators has led to optimized nanocomposite film packaging formulations for the Meal, Ready-to-Eat™ Meal Bag, non-retort and retort pouches. Currently, the NSRDEC is demonstrating and validating this technology through large-scale manufacturing and operational testing of Meals, Ready-to-Eat (MREs) which utilize nanocomposite packaging. These engineering accomplishments will lead to lightening the load for the Soldier and decreasing the amount of solid waste generated by the Army.

Nanocomposite Meal Bag for Meal, Ready-To-Eat™

Currently, the Meal Bag is fabricated from 11 mil (280 microns) thick low density polyethylene (LDPE). NSRDEC engineers have successfully produced a 6 mil (152 microns) thick nanocomposite Meal Bag which meets all performance requirements. The nanocomposite Meal Bag formulation consists of melt processed LDPE and 7.5% (wt/wt) montmorillonite-layered silicate (MLS) nanoparticles, which show significant improvements in mechanical, thermal and gas barrier performance, compared to neat LDPE films, as evidenced in Table 1. These performance improvements were first demonstrated using laboratory scale, 5-pound processing trials. Subsequently, these trials were successfully scaled up to 300-pound and 1000-pound pilot plant trials. Successful scale-up is an essential milestone in proving the validity of the research, verifying the producibility of polymer nanocomposites, and transitioning the technology to advanced development.

Table 1: Summary of Nanocomposite Meal Bag Properties

	Current MRE™ Meal Bag	**Neat Low-Density Polyethylene Film**	**Nanocomposite Low-Density Polyethylene Film**
Film Thickness	11-mil	6-mil	6-mil
Oxygen Transmission Rate (cc-mil/m²-day)	8264	9097	3703
Young's Modulus (MPa)	127	93	186
Onset of Thermal Degradation (°C)	351	370	450
Insect Infestation Test	Pass	Fail	Pass

Nanocomposite Non-Retort Pouch

The current non-retort pouch is a tri-laminate structure with foil as the barrier layer. Kuraray and NSRDEC have successfully optimized multilayer film structures for the non-retort pouch, which utilize a nanocomposite coating as the barrier layer. Kuraray has developed a multilayer film with high barrier properties, suitable for applications where barrier to oxygen and water vapor are critical. Kuraray's nanocomposite barrier films incorporate functionalized nanoparticles into a coating for barrier polymers, nylon and/or polyethylene terephthalate. These optimized formulations have produced films with >30% improvement in barrier properties against oxygen and water vapor in comparison to some earlier formulations. Kuraray has conducted research and worked with the team at NSRDEC to evaluate the feasibility of using Kuraray's multilayer films for food packaging in an effort to reduce packaging waste for military applications. NSRDEC is satisfied with the performance properties and the focus will be to manufacture sufficient quantities of film for further evaluation under this ESTCP program.

Nanocomposite Retort Pouch

The current retort pouch is a quad-laminate foil-based structure. NSRDEC is collaborating with Kuraray to develop an all-polymer film structure, which employs a high barrier nanocomposite coating, for retort pouch applications. This barrier material, KURAISTER N™ is thin (1um), but has extremely durable coating on both sides of a nylon substrate. Toppan GL-ARH, an inorganic barrier coated film, was also used to enhance water vapor barrier. Rohm and Haas's MorFree 225/C33 was chosen as the optimal adhesive for the film laminations to avoid a potential blistering issue in double barrier lamination (Toppan GL-ARH // KURARISTER N) This material has been shown to yield excellent barrier properties before and after retort. It also has undergone Gelbo flex testing experiments and the OTR is nearly the same after the flexing suggesting that the nanocomposite coating is extremely durable. This film is currently being tested under operational environments to demonstrate and validate the technology.

Contributing Agency: DoD/NSRDEC