Argonne NATIONAL LABORATORY

Nanocomposite Technologies

NEW

NANOCOMPOSITES AND ORGANOCLAYS

INCREASE PRODUCT PERFORMANCE AND LOWER PRODUCTION COSTS

BENEFITS

√ Eliminate need for expensive drying, crushing, and coupling agents.

√ Improve gas barrier performance of waxes up to 2,500 times.

√ Self-activating and fully dispersible in polymers and waxes.

√ Loadings as low as 5% greatly enhance properties of materials.

LINKS TO ONLINE INFORMATION:

How to license Argonne technologies:
http://www.anl.gov/Working_with_Argonne/index.html

Argonne's Chemical Engineering Division:
http://www.cmt.anl.gov/

To improve control over the rheology (flow characteristics) and mechanical properties of polymers, Argonne National Laboratory has developed a new and cost-effective method of producing polymer-clay nanocomposites (PCNs) using almost any nonpolar, commercial polymer (e.g., polyolefins, elastomers, and ionomers). Argonne's self-activating PCNs are fully dispersible without using expensive co-polymers or dispersing agents, which translates into higher performance at a lower cost. The Argonne technology produces nanometer-scale clay particles that completely disperse when added to a polymer mix. The clays can greatly enhance a product's thermal stability, improve stiffness and strength, and increase gas barrier performance – without losing impact strength or significantly increasing density.

Argonne's patented process begins with a clay purification method that selectively separates and recovers exfoliated nanoclays. These clays are mixed with surfactants, filtered, and can then be combined in a flushing operation with polymers, such as polyethelene, before being extruded into an intercalated "master batch" comprised of 50-75 percent clay. End-users, such as polymer converters and compounders, can mix Argonne PCNs with other polymers for use in a variety of products.

Barrier Applications: The Argonne technology can be used to produce transparent nanoclay dispersions in many thermoplastic polymers at clay loadings of 2-20 percent or higher. The oxygen barrier properties of these nanocomposite films are more than 200,000 times better than oriented polypropylene and over 2,000 times better than Nylon-6. The technology reduces by tenfold the requirement for costly organic modifiers.

Structural Applications: Controlling polymer flow, shrinkage, and other properties is greatly simplified when using Argonne PCNs in a manufacturing process. At loadings as low as 5 percent, gaps and holes in products are eliminated, and thinning or tearing at corners and edges of structural products is minimized or eliminated. The complete dispersal of the clay particles also permits extremely clear thermoplastic structures for use in a wider range of packaging and container applications.

Nanocomposite Waxes: Argonne has also improved the gas barrier properties of waxes for packaging by approximately 2,500 percent. A new type of nanocomposite waxes has shown to adhere well to paper and other substrates, and can easily be applied using conventional coating equipment. The emulsified nanocomposite wax can be recycled in the same manner as conventional coatings.

TECHNOLOGY STATUS

Argonne is seeking industrial partners to further develop and/or test its organoclays and polymer-clay nanocomposites in a wide range of applications. A supplier of thermoplastic polymers that could manufacture and provide interested parties with quantities of master batch nanocomposites for testing is also being sought.

The nanocomposite technologies are available for commercialization under a variety of agreements. For more information, contact William D. Ingle, III 630-252-4694, or contact the Argonne Office of Technology Transfer at 1-800-627-2596 or e-mail us at partners@anl.gov.

ORGANOCLAYS FOR WATER TREATMENT

Argonne organoclays can offer dramatic performance improvements in many water treatment and other adsorption applications, including removing oil, grease, heavy metals, and polychlorinated biphenyl; organic matter, such as humic and fulvic acids; polynuclear and polycyclic aromatics; and sparingly soluble hydrophobic, chlorinated organics. Removing radionuclides, including pertechnetate, from water is another application with tremendous potential.

NANOCOMPOSITES CAN REVOLUTIONIZE THE MARKET

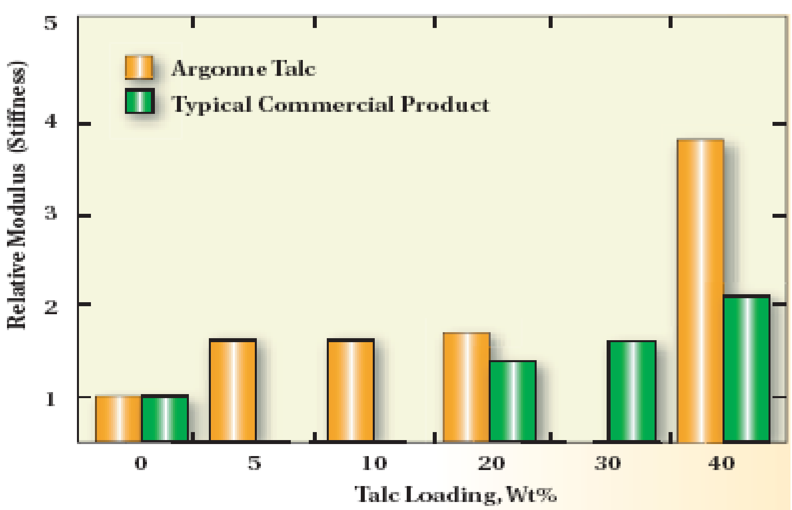
For Argonne research partners and/or licensees, there exist significant marketing opportunities with Argonne's advanced organoclays and polymer-clay nanocomposites (PCNs). The increasing demand for high-performance fillers, plastics, and composites — combined with the ability of Argonne's technologies to actually lower the cost of these materials — will help open up many applications, including automotive, packaging (structural), and packaging (gas barrier).

Technology/Application	Estimated Market Size* (by 2009)
Polymer-Clay Nanocomposites:	Over 1 billion pounds:
Packaging	367 million pounds
Automotive	345 million pounds
Building & Construction	151 million pounds
Coatings	63 million pounds
Industrial	48 million pounds
Other	67 million pounds

*Source: Principia Partners – *Nanocomposite Polymer Technology for the Next Century*

ARGONNE'S NEW SURFACTANT-TREATED TALCS OFFER HIGH PERFORMANCE AT JUST 5% LOADING IN POLYPROPYLENE

Argonne has also developed semi-exfoliated, surfactant-treated talcs that require only one-sixth the amount of talc loading used in conventional talc-filled polypropylenes, yet deliver the same improvements in mechanical performance – without significantly increasing the material's density. For example, a 5 percent loading of Argonne's surfactant-treated talc offers the same mechanical properties seen at a 20-30 percent polypropylene talc loading. Argonne's surfactant-treated talcs also do not require any expensive coupling agents, such as maleated polypropylene co-polymers.



The data in the bar chart show the effect of compounding the first-generation Argonne-modified talc into polypropylene. With only 5 wt% mineral loading, the modulus is increased by 62%. This compares favorably with conventional talc-filled polypropylene, which generally produces a more modest increase in modulus of 30–40%, but requires four times the mineral loading. At the highest loading levels, the Argonne materials are almost twice as stiff as conventional talc-filled polypropylene.

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