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Accidental Discovery Has Potential To Keep Food And Drugs Safer And Fresher Longer

ScienceDaily (Feb. 6, 2009) — A recent discovery at Case Western Reserve University may help keep food and drugs safer and fresher longer and electronic equipment dryer and more secure than ever before – all at a lower cost.

The finding involves a nanotechnology-based technique to block the transport of damaging gases through a polymer, making it stronger while using less material. It was made in the labs of the National Science Foundation-supported Center for Layered Polymeric Systems (CLiPS) at the Case School of Engineering.

The findings are published in the Feb. 6, 2009, issue of the journal *Science*.

"This work takes a step toward developing more flexible, optically transparent, ultra-high barrier polymers for several different applications," said Anne Hiltner, lead author of the study and the Herbert Henry Dow Professor of Science and Engineering at Case Western Reserve. She also serves as lead investigator and co-director of CLiPS.

The discovery was a serendipitous find, according to Hiltner. The researchers found that when confined as nanolayers, polyethylene oxide (PEO) crystallizes as a single layer, resembling very large, impermeable single crystals that reduce by 100 times the amount of gas permeability in all kinds of polymer-based applications. When a crystallizable polymer is confined to such thin layers, it surprised the researchers by spontaneously organizing themselves into a nearly perfect crystalline packing of the polymer chains in each thin layer, Hiltner says.

Crystalline regions of polymers are areas where the atoms in polymer chains line up relative to one another in a rigorous and well-defined, ordered pattern, much like water molecules align next to each other in a well-defined pattern in ice (which is, in fact, crystalline water). Because the atoms are closely aligned to each other in a regular pattern, crystalline regions of polymers do not permit the transport through them of even the smallest gas molecules, such as oxygen or carbon dioxide. Thus, crystalline regions of polymers decrease the permeability of gases through such polymers – that is, crystalline regions improve barrier properties of polymers.

"To find something as unexpectedly as we did is the kick you get out of exploring," Hiltner said.

This spontaneous organization of a polymer melt into large (in terms of length and width), nearly perfect, so-called single crystals has not been observed before this study, according to Benny Freeman, the Kenneth A. Kobe Professor of Chemical Engineering at the University of Texas at Austin and co-author of the study.

"The ability to produce literally kilometers of film containing single crystals of polymer is unprecedented," Freeman said.

Crystalline polymers, such as polyethylene, polypropylene and nylon, have been broadly used as gas barrier films in food, medicine and electronics packaging, benefitting from their low cost, easy processing and mechanical toughness.

Using an innovative layer-multiplying co-extrusion process that takes two polymer melts and combines them as layers, multiplies the layers to four, and doubles that again as many times as desired, the research team discovered that a new structure emerges as confined polyethylene oxide (PEO) layers are made progressively thinner, thereby saving material.

Polymers are already used in many applications where their ability to keep wrapping tightly sealed is critically important to the performance of the application, such as in food and medicine packaging. Yet there are emerging technologies, such as flexible electronic displays, where the barriers of current polymers are not sufficient to meet the needs of the application.

Adapted from materials provided by Case Western Reserve University, via EurekAlert!, a service of AAAS.

Case Western Reserve University (2009, February 6). Accidental Discovery Has Potential To Keep Food And Drugs Safer And Fresher Longer. *ScienceDaily*. Retrieved February 7, 2009, from http://www.sciencedaily.com/releases/2009/02/090206120547.htm