High Performance Nanostructured Organic/Inorganic Hybrids for Functional Applications

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Introduction:

- α-Zirconium phosphate (ZrP), a nano-dimensional material with a layered structure, has an ease of surface functionality control, intercalation, and exfoliation, as well as great gas barrier properties.¹

- Montmorillonite (MMT), another nano-dimensional material with a layered structure, is abundant, inexpensive, and has great gas barrier properties.¹

- Polyvinyl alcohol (PVA), a water soluble polymer, is inexpensive and an excellent film-former. It is also commonly found in textiles and coating materials.¹

Market:

- Compared to glass or metal packaging, plastic packaging is permeable to a number of small molecules like oxygen and water.²

- These small molecules, especially oxygen and water, are responsible for the eventual deterioration of food.³

- Approximately 31% (133 billion tons) of food in the U.S. went uneaten – this is about 161.1 billion dollars wasted.⁴

- Therefore, it is important to develop a material that can retard the pathway of these molecules, thus prolonging the shelf life of food.

By increasing gas barrier properties, the longevity of food can be preserved, saving money for both supermarkets and households.

Objective: To create a nanostructured organic/inorganic hybrid that has excellent gas barrier properties

Methods:

- ZrP was exfoliated, undergoing stirring and sonication. Exfoliating agents tetrabutyl ammonium hydroxide (TBA) or propylamine was removed using HCl.

- PVA was then added to either the exfoliated ZrP or MMT dispersion.

- Films such as Polyethylene Terephthalate (PET) and High-Density Polyethylene (HDPE), were coated with either ZrP/PVA or MMT/PVA using flow-assist coating.

Results:

- UV-vis spectra show high transparency of the coated films.

- The clarity of the UConn logo underneath the coated film illustrates the film’s transparency.

Conclusions:

Nanostructured ZrP/PVA and MMT/PVA organic/inorganic hybrids are successful in lowering both oxygen and water vapor transmission rate. The coated films also remain to be highly transparent.

Further Research:

- Tests will be conducted in order to determine whether these nanostructures have good flame retardancy.

- Varying concentrations of ZrP or MMT, and PVA, and observing its effects on OTR, WVTR, and transparency.

- Transmission Electron Microscopy to determine the distribution of ZrP

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Citations: