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Industrial Postdoc/Postmaster : กำลังคนคุณภาพสูงเพื่อสนับสนุนอุตสาหกรรมยุทธศาสตร์ของประเทศ

30 มีนาคม 2567

สำนักงานพัฒนาวิทยาศาสตร์และเทคโนโลยีแห่งชาติ

Nanocoating materials for packaging and energy technology

Research topic

Feasibility study of high barrier coating from solution-based coating

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Introduction

Food packaging

✓ A physical shield, prevents the food from interacting with its surroundings (microorganisms, dust, moisture, light, and gases)

Problem

✓ Exposure of food to these factors can lead to its degradation and spoilage

Troubleshooting

To reduce spoilage risks

Develop and formulate a solution-based coating material

Apply on the surface of plastic packaging to inhibit the permeation of moisture and oxygen

"Preserve quality and extend the shelf life"

Introduction

Film

Polyethylene (PE) film thickness 25 micron

Polyethylene terephthalate (PET) film thickness 12 micron

Coating material	Advantage
Polyvinyl alcohol (PV)	Water-soluble, semi-crystalline polymer, low oxygen permeability, good thermal and organic solvents resistance, excellent adhesive properties, biocompatibility and biodegradability properties
Fatty acid (FA)	Organic solvent-soluble, water repellent property, and non-toxic
Graphene (GP)	Hydrophobicity, preventing oxygen diffusion, applicable to the food packaging

N. Hashim, et al. Graphene and 2D Materials Technologies. 7, (2022), 1–29. S. Merritt, et al. Composites Materials for Food Packaging (2018). V. Rossa, et al. RSC Adv. 2022, 12, 14084–14111.

Objective

1. To improve the efficiency of food packaging, thereby enhancing the preservation of quality and prolonging the shelf life of food products

2. To improve a barrier property of PE and PET films and ensure they meet the requirements of WVTR and OTR below 1 g/m^2 day by applying solution-based coating on surface

3. Comparative analysis of WVTR and OTR between single-layer and muti-layer coating

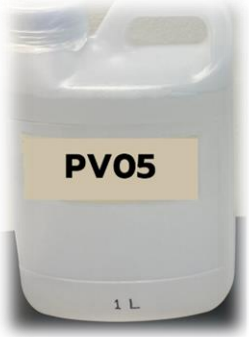
4. To preserve the characteristics of PE and PET films (thin and transparent film)

5. Develop and broaden strategies for creating innovative coating solutions and techniques, making them suitable for industrial-scale application

Surface treatment & Coating technique

Solution-based Coating

☑ Preparing polyvinyl alcohol (PV) plus crosslinking agent (02,03,05)



1st Coat & Dry

☑ Preparing S-graphene (SGP)

2nd Coat & Dry

☑ Preparing fatty acid-graphene (FA-GP)

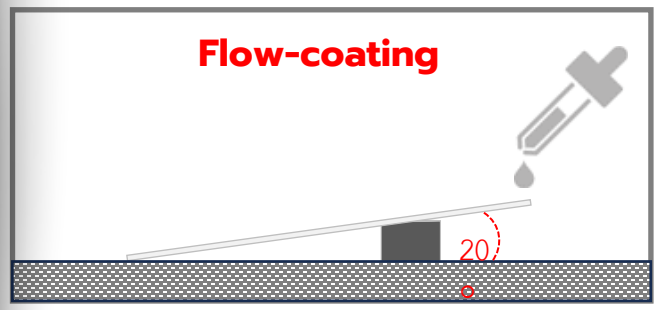
3rd Coat & Dry

*Drying temperature = 90-100 °C

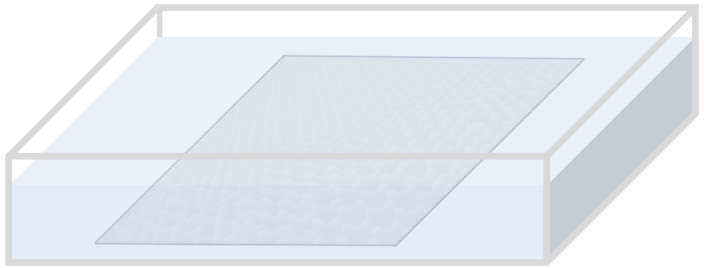
Coating techniques

With and without surface treatment

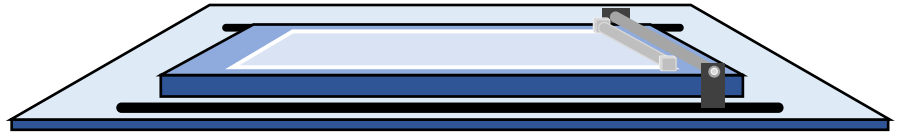
Flow-coating



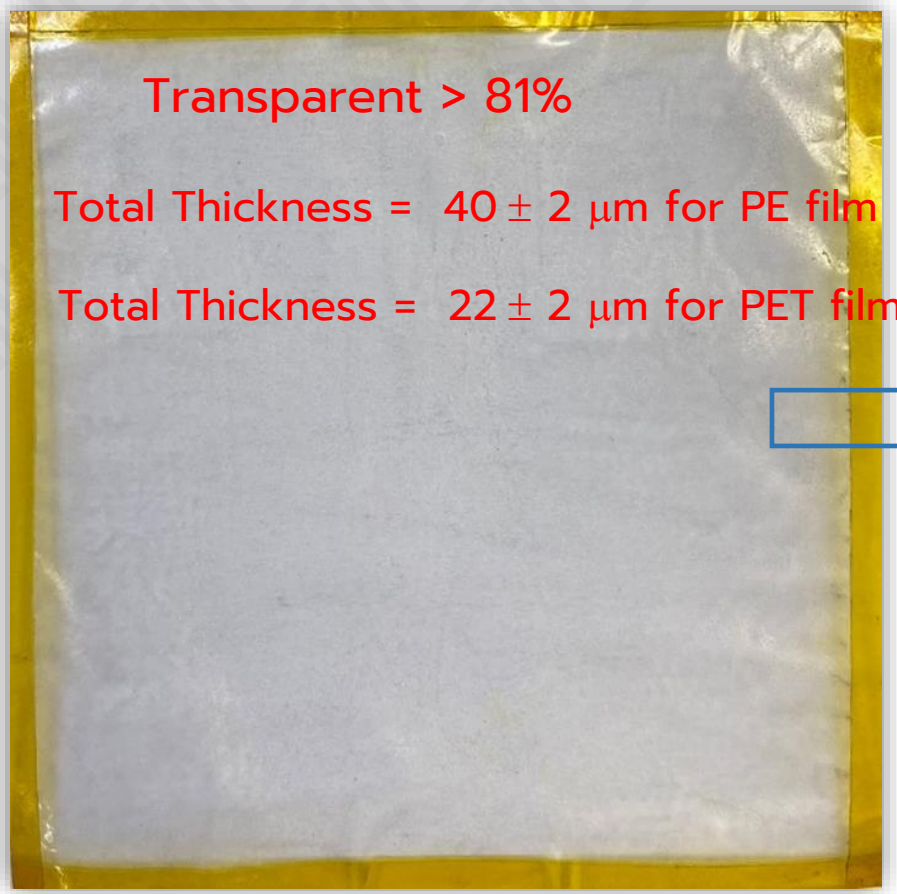
Dip-coating

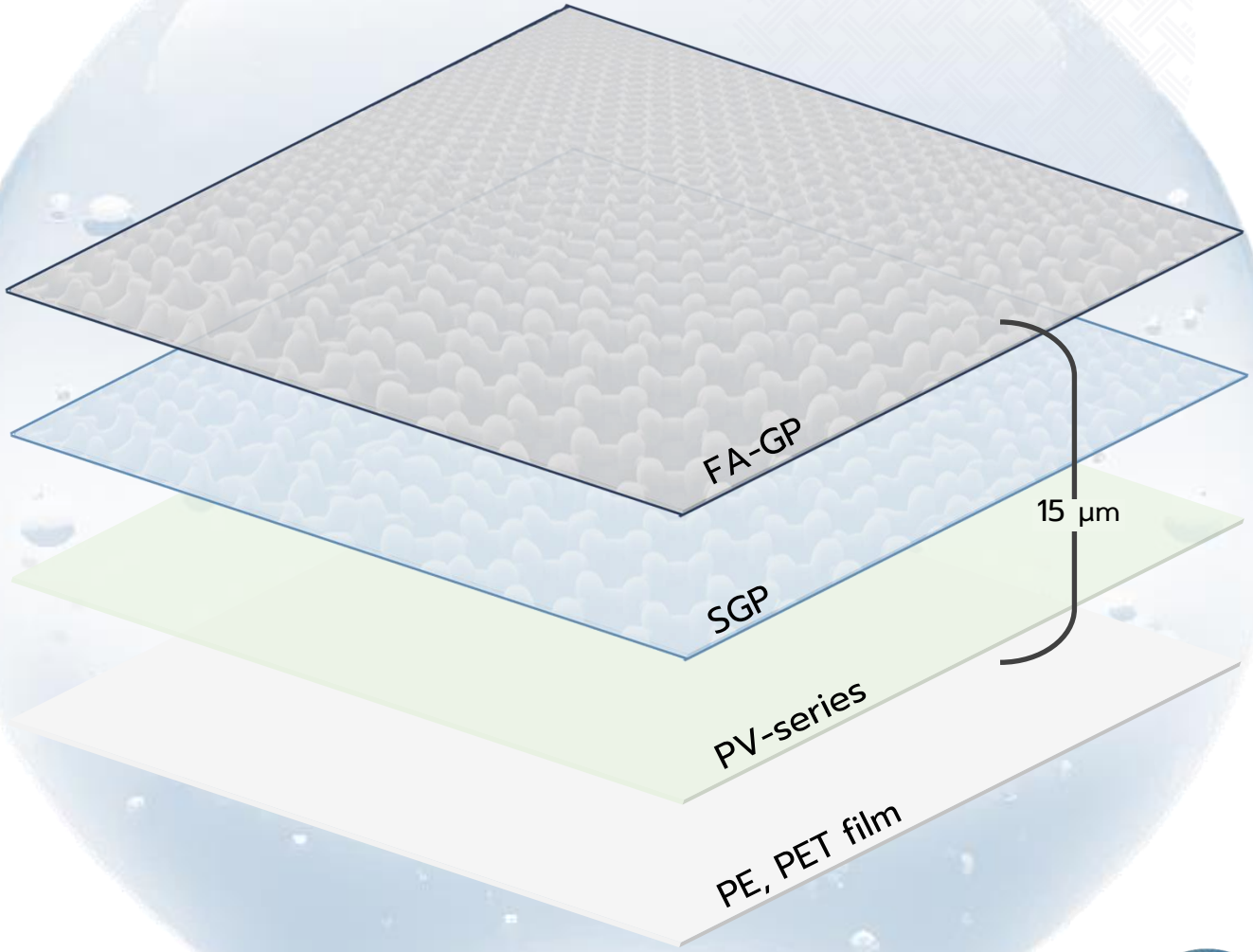


Bar-coating

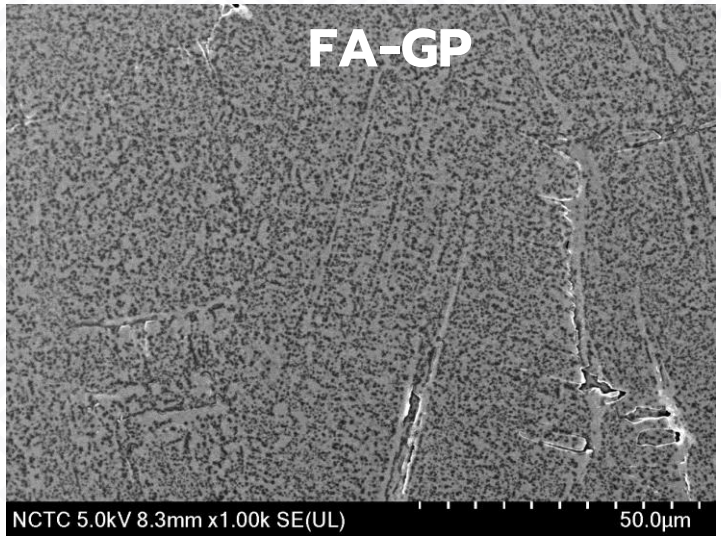


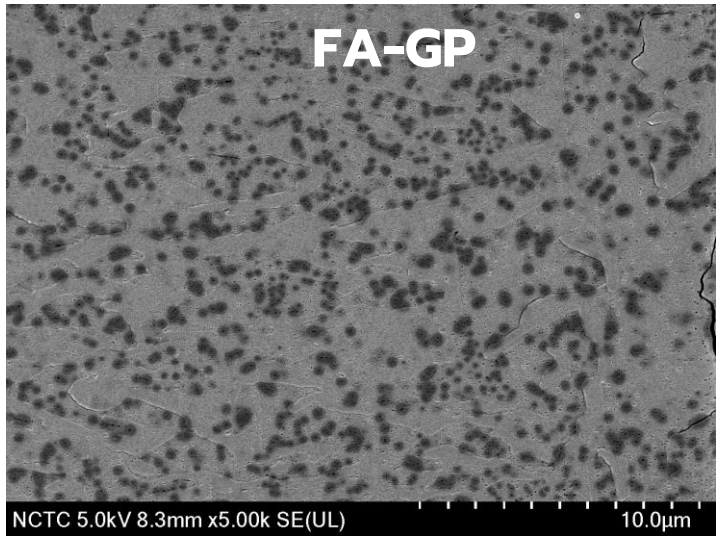
Thin Film Coating

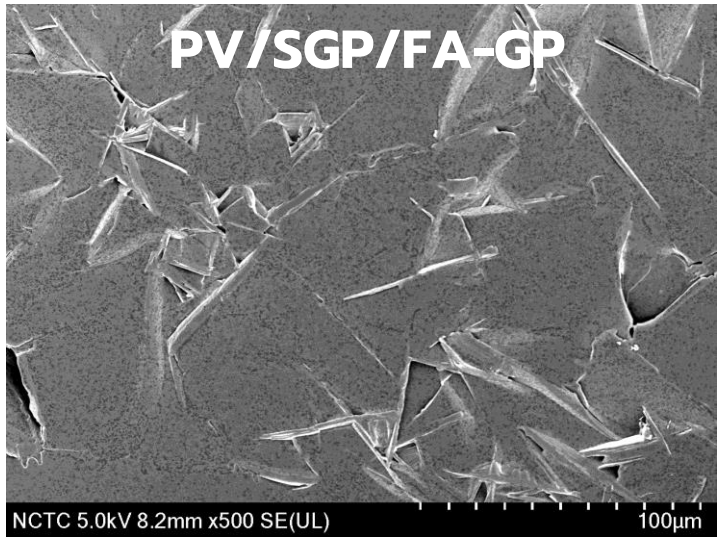


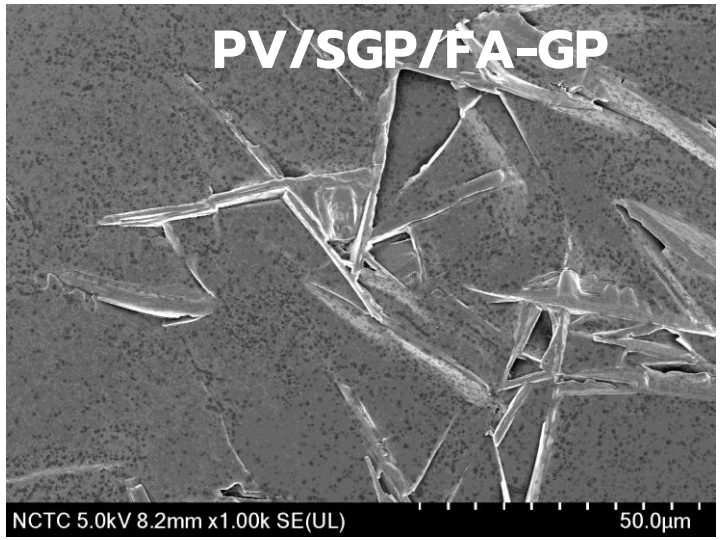


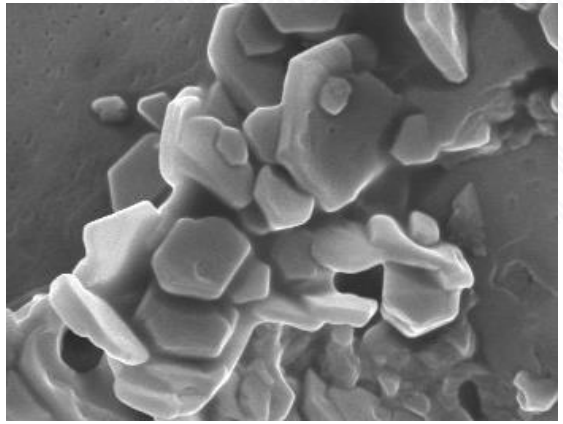
Surface of coating film



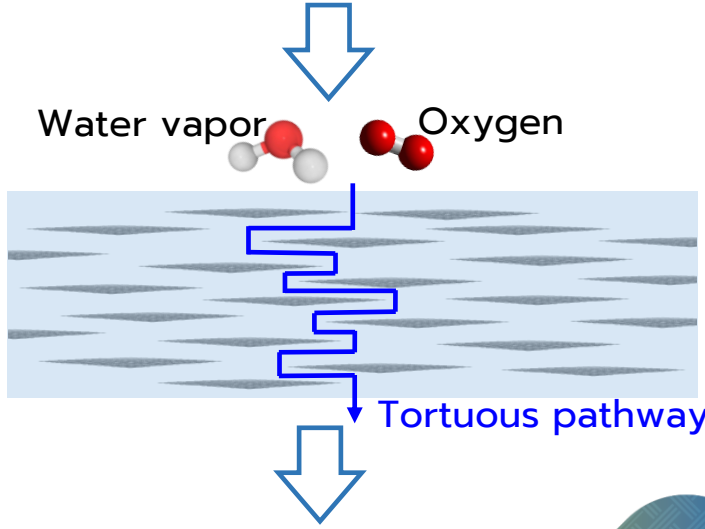








☑ Well-dispersed GP in film



☑ Increase barrier efficiency

WVTR & OTR of Single layer coating

☑ PERMATRAN-W 3/34 WVTR Analyzer

WVTR = Water Vapor Transmission Rate

Condition = 37.8 °C, 90%RH (ASTM F1249)

☑ MultiPerm O_2 H_2O Permeability Tester

OTR = Oxygen Transmission Rate

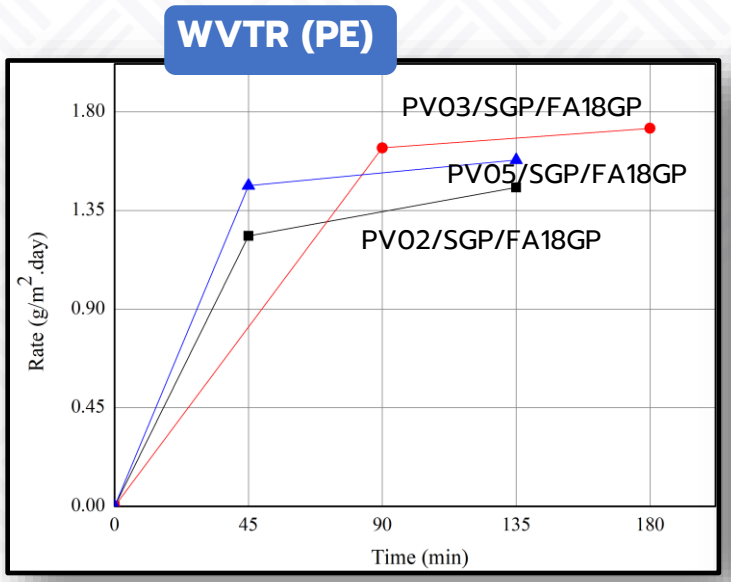
Condition = 23 °C, 50%RH

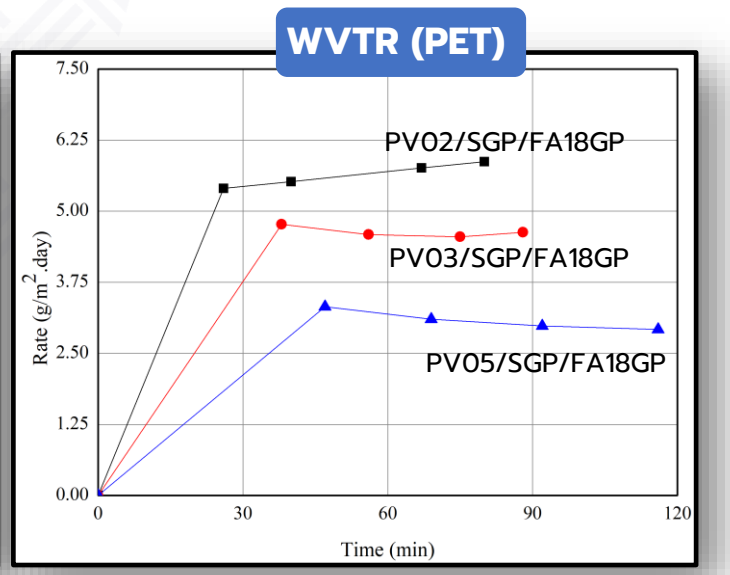
Sample (PE)	Thickness (μm)	WVTR (g/m².day)	OTR (cc/m².day)
PV01	33	8.02	4.82
PV02	29	7.24	0.73
PV03	32	7.70	2.27
PV05	29	4.76	1.51
PV03/SGP	30	7.20	0.27
PV03+GP	29	7.15	0.56
FA-GP	34	0.64	High
FA-GP (PET)	19	1.30	High

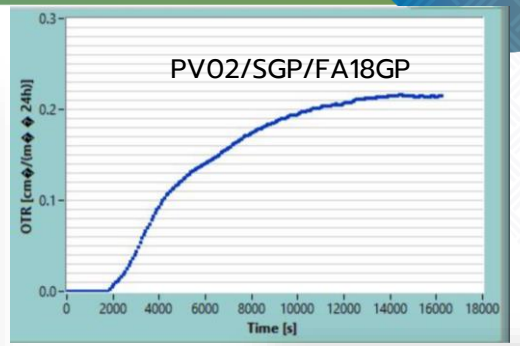
Note: WVTR = 7.2 g/m².day for PE, 42 g/m².day for PET

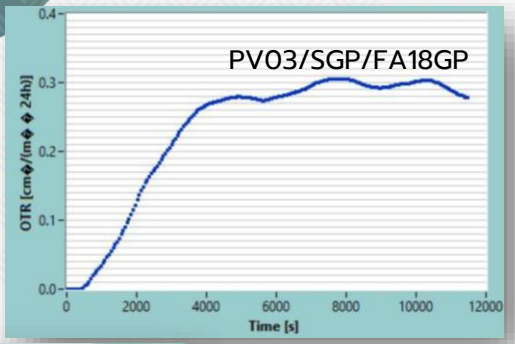
OTR >400 g/m².day for PE, >400 g/m².day for PET

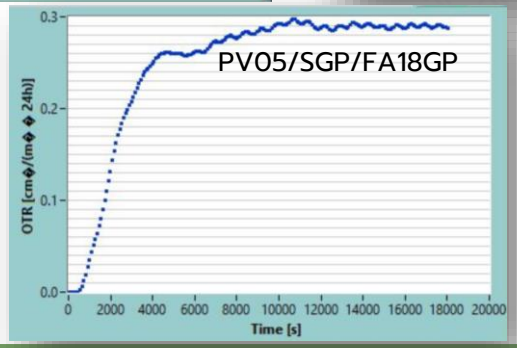
WVTR & OTR of Multilayer coatings











Coating agent	PE Film			PET Film		
	Thickness (μm)	WVTR (g/m².day)	OTR (cc/m².day)	Thickness (μm)	WVTR (g/m².day)	OTR (cc/m².day)
PV02/SGP/FA-GP	42	1.45	0.00	26	5.76	0.21
PV03/SGP/FA-GP	41	1.73	0.00	29	4.55	0.29
PV05/SGP/FA-GP	41	1.58	0.00	28	2.92	0.29

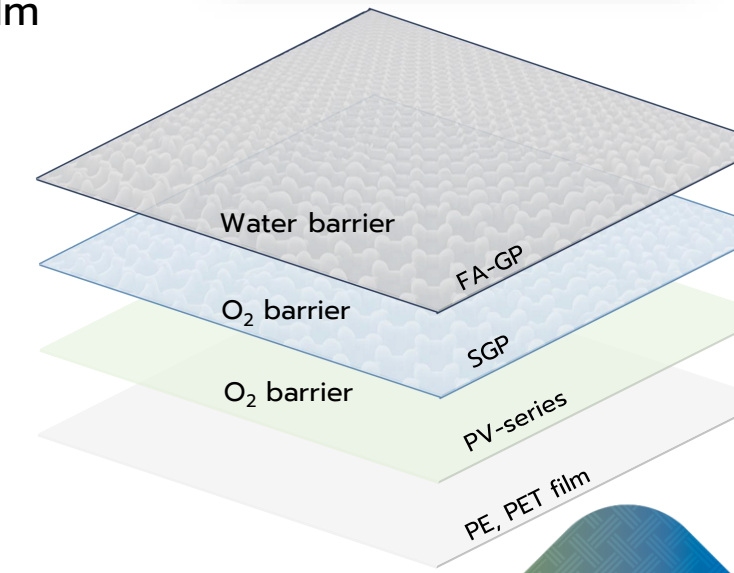
Conclusions

✓ Obtain high-efficiency PE and PET films for food packaging

✓ Achieve high barrier property for PE with WVTR and OTR below 1 g/m^2.day or cc/m^2.day by employing a single-layer coating of FA-GP for WVTR and PV02 for OTR

✓ Achieve high barrier property with WVTR and OTR approached to 1 g/m^2.day and 0 cc/m^2.day for PE film and WVTR 2-5 g/m^2.day and OTR 0.2 cc/m^2.day for PET film by employing multi-layer coating of PV/SGP/FA-GP

✓ Prepare through a simple, low-toxicity process, suitable for industrial-scale application and compatible with laminated films



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