

## MULTI-MATERIAL RECYCLATE SOURCES

- Multi-material films combining different polymers are used in a wide variety of food packaging. Primarily post industrially sourced.

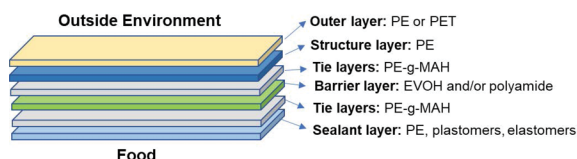


- Post-consumer baled polyethylene (MRF output) contaminated with other polymers.



## CHALLENGES FOR MULTI-MATERIAL FILM RECYCLING

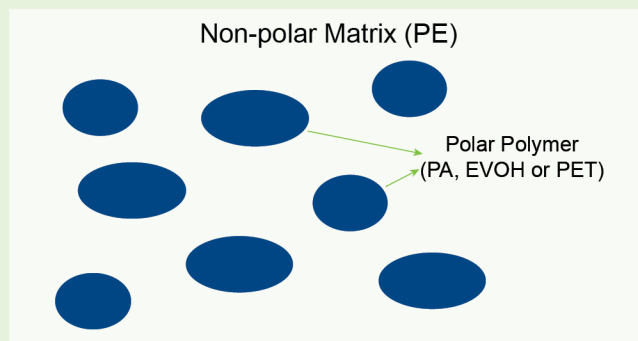
- Polymers used in multilayer films are immiscible and can't be separated.
- Recycling without separation, or failing to compatibilize leads to lower quality recyclate.



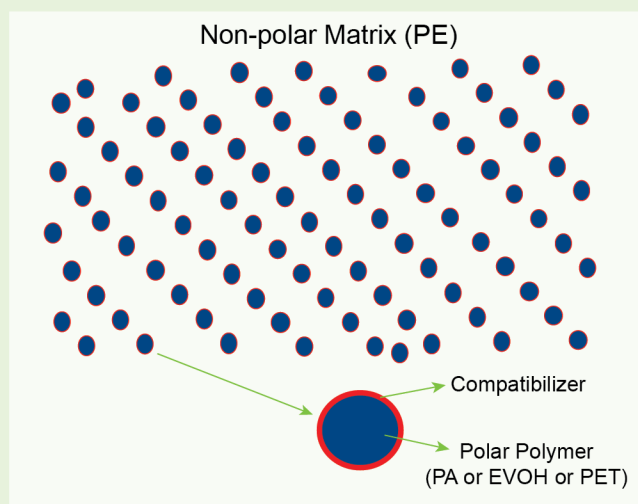
## ROLE OF COMPATIBILIZER

- Reduce the particle size of the polar phase.
- Bring uniformity to the particle size distribution.
- Increase the interfacial adhesion between the non-polar matrix and polar phase.

### WITHOUT COMPATIBILIZER



### WITH COMPATIBILIZER



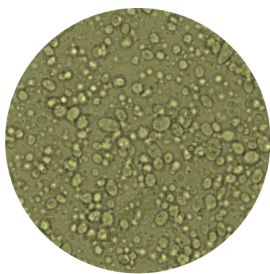
## INGENIA NEXT GENERATION PE/PA AND/OR EVOH COMPATIBILIZER:

### INGENIA CIRCLE® IP1601

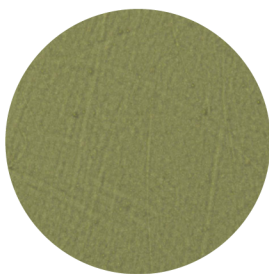
- Much lower letdown ratio is required compared to prior generation compatibilizer.
- Complies with FDA food contact regulation.
- Studies with PE/PET lamination structures underway.
- Passed internal APR recognition required tests for up to 20%nylon and 20%EVOH (29 mol% ethylene content) as well as 15%nylon + 5%EVOH for recycle ready film formulation design. 3rd party lab testing is underway.

## COMPATIBILIZATION EVALUATION – MICROSCOPY

With the addition of 2% INCIRCLE® IP1601, 20% PA6 can be easily incorporated into PE. The particle size of PA6 domains is reduced from up to 25µm to undetectable under microscopy.



20%PA6 without INCIRCLE® IP1601



20%PA6 with INCIRCLE® IP1601

## COMPATIBILIZATION EVALUATION – BLOWN FILM



2%IP1601+20%PA6 in b-LLDPE

Good compatibilization is very important for blown film processing. Blends with poor compatibilization can't achieve a stable bubble and result in poor film quality with pin holes or high gel counts. With addition of 2% INCIRCLE® IP1601, a stable bubble and good quality film can be achieved with blends of up to 20% barrier resin.

## CONTACT CLARITY

Clarity is another important property for flexible packaging film. Poor compatibility not only limits the recyclate content in the final film, but also affects the clarity of the film due to large polar polymer domain size. With 2% INCIRCLE® IP1601, film with 20% polar polymer can maintain relatively good transparency.



2%IP1601+20%EVOH in o-LLDPE



2%IP1601+20%PA66 in o-LLDPE

## MECHANICAL PROPERTIES

Mechanical properties are one of the most important film properties. Failure to compatibilize immiscible polymer blends will result in poor mechanical properties, which limit the application of the recycle film. With 2% INCIRCLE® IP1601, film with 20% polar polymer maintains relatively good mechanical properties as compared to film made with virgin resin.

