

AMI: Multilayer Flexible Packaging 2019

Recyclability of Multilayer Packaging Film

Ali Goger, Richard Siewsankar and Patrick Greenidge



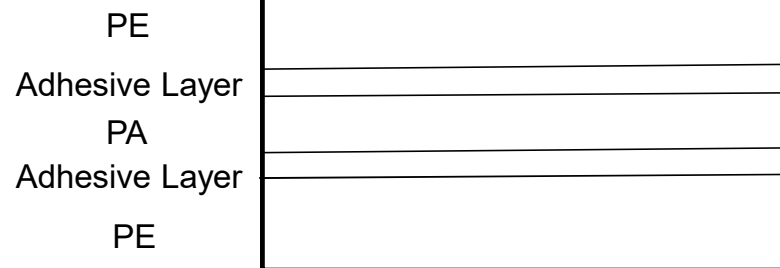
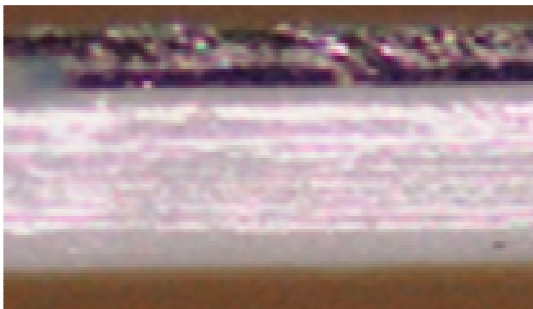
Who is Ingenia?



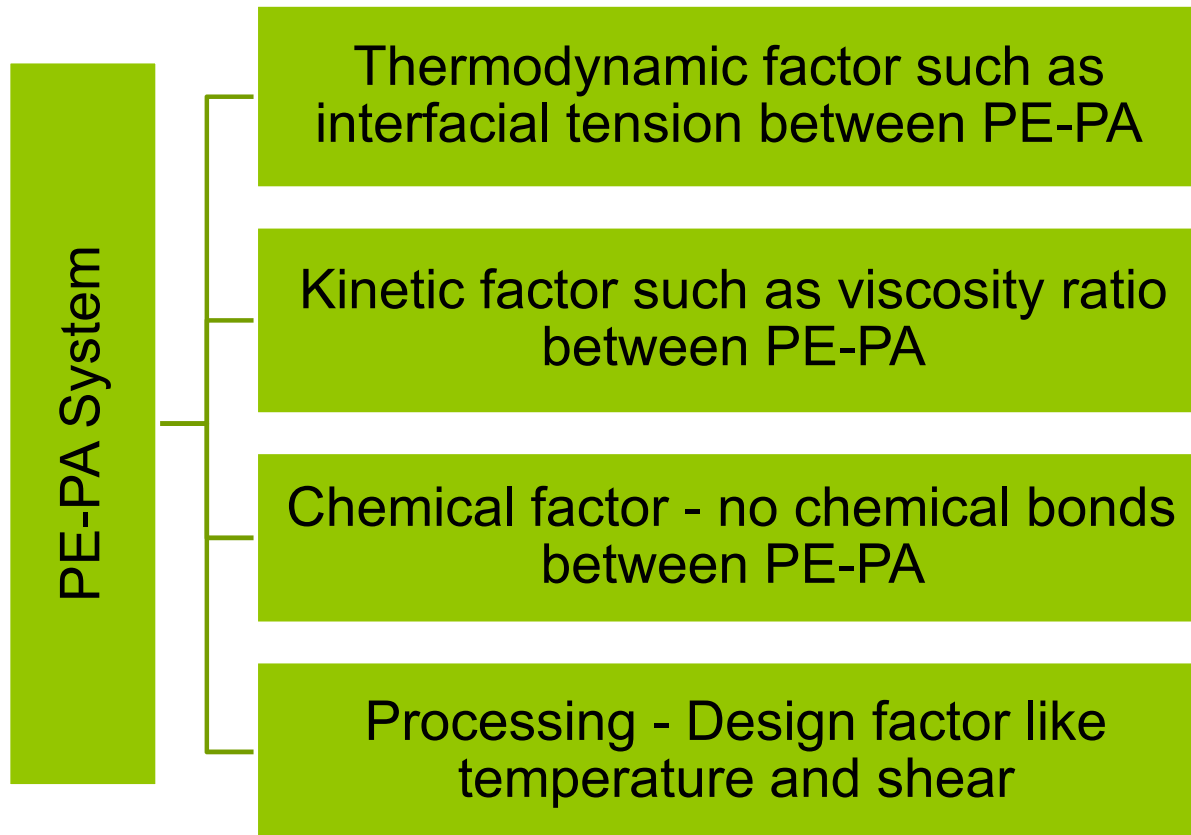
- Founded in 1986 as WedTech and renamed Ingenia Polymers Corp. in 1998
- Four main manufacturing sites located in: Brantford (Canada), Calgary (Canada), Houston (USA) and Al-Jubail (KSA)
- Specialized in Additive Masterbatch, Superlink[®], Black and White Masterbatches, Rototuff[®], Ingenia Superblend[®] and Product Development

Opportunities in Multilayer Films

- PE layers provide moisture barrier, sealant and surface tension properties.
- PA or EVOH layer provides oxygen barrier, mechanical reinforcement and high temperature stability.
- The market size of post-consumer flexible packaging is 12 Billion lbs*.
- Only 209 Million lbs. of post-consumer films are recycled (i.e. 1.7%).



Challenges in Multilayer Films



Advantages of Compatibilized Recycle Films

Advantages of Compatibilized System

- Enhanced mechanical properties because of improved interfacial adhesion.
- Elimination of discrete resin coalescence after material passes through the die.
- Uniform flow properties because of improved molecular structure.
- Allow higher usage of repro in the end-user product.
- Allows shorter purging time

Disadvantages of Non-Compatibilized System

- Low tensile and impact properties of film for end-user's application.
- Non-uniform thickness due to viscosity difference.
- Ugly appearance due to gel formation.
- Limitation on repro usage.

Objectives

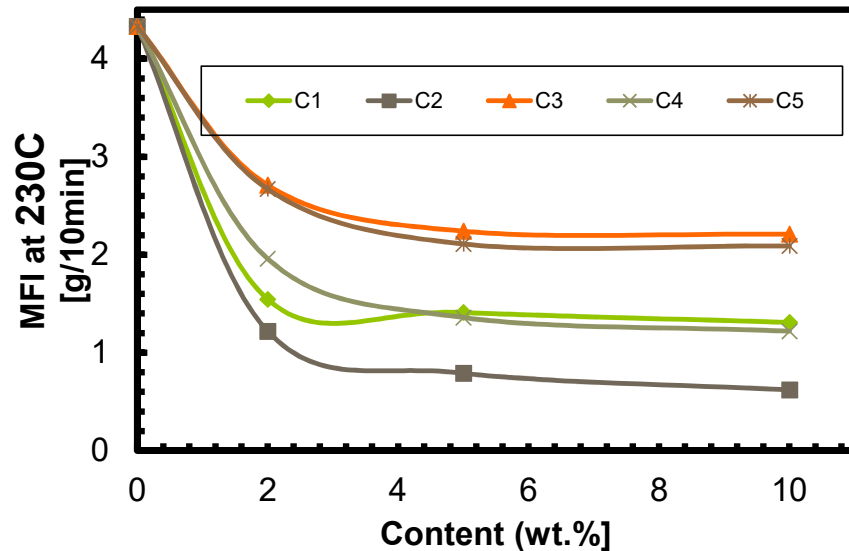
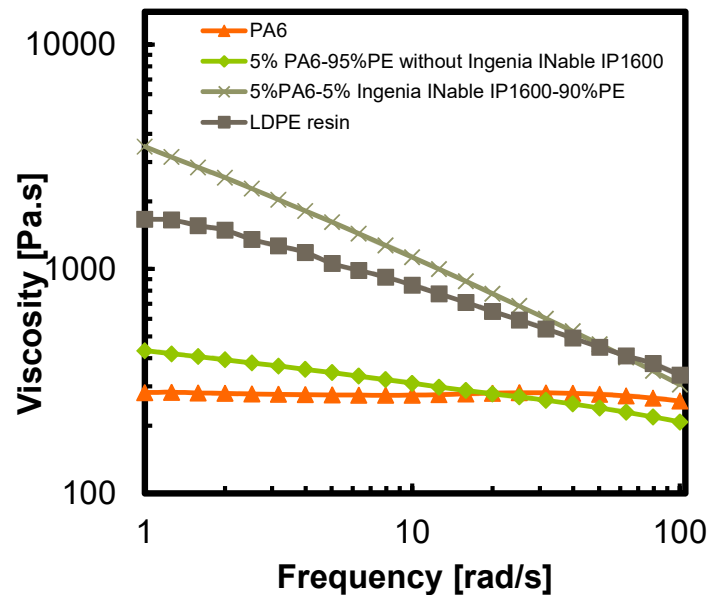
- Introducing new Ingenia INable IP1600 compatibilizer for PE-PA and/or EVOH system.
- Introducing different measurement technique to evaluate the compatibilization of PE -PA and/or EVOH.
- Introducing applications for Ingenia INable IP1600 product.

Material and Experiments

- EVOH, PA6 and PA666 are evaluated at different concentration.
- Monolayer blown film extrusion line is used. (Diameter:42mm L/D:26).
- All the films are at 2mil thickness and BUR~ 2.
- Compatibilization of the system are examined with rheology, differential scanning calorimeter (DSC) , tensile and impact properties test.
- ASTM D3418 for DSC, ASTM D1709 for impact test and ASTM D638 for tensile test are applied for measurements.

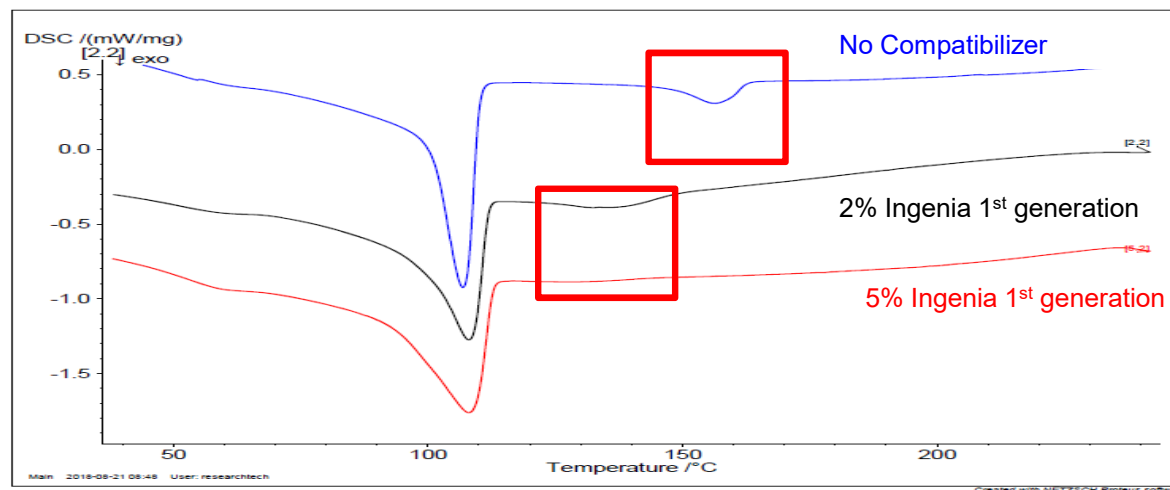
Rheology

- Viscosity increases when two polymer matrices are compatibilized.
- The initial changes can be observed quite clearly however further compatibilization changes cannot be detected.



Differential Scanning Calorimeter (DSC)

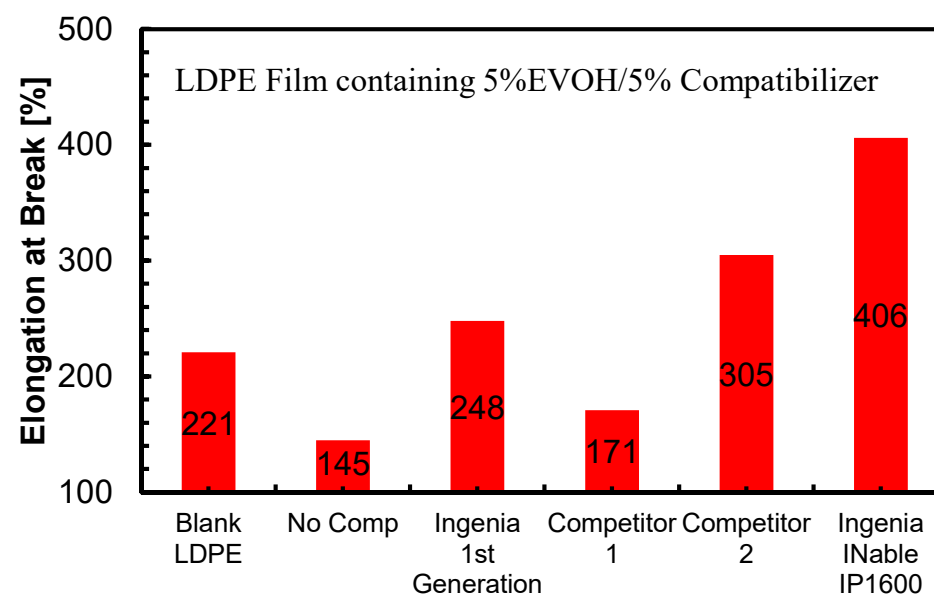
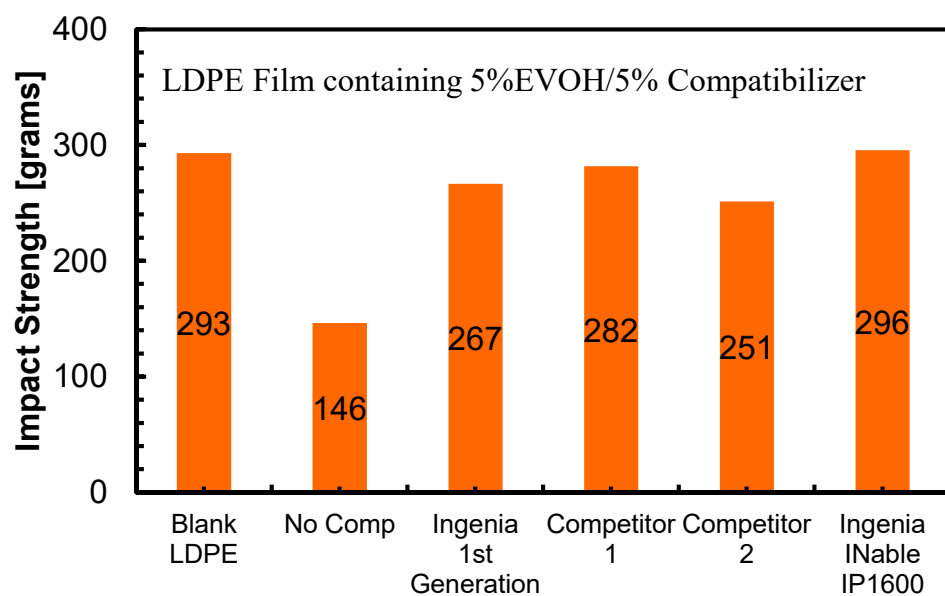
- When polymer is crystallized in small domains, crystallization occurs at temperature much lower than its characteristic crystallization temperature.
- DSC T_c is an accurate method for evaluating compatibilization of PE-PA systems, with the drawback that the specimen size is very small.



Mechanical Properties



FOR EVOH

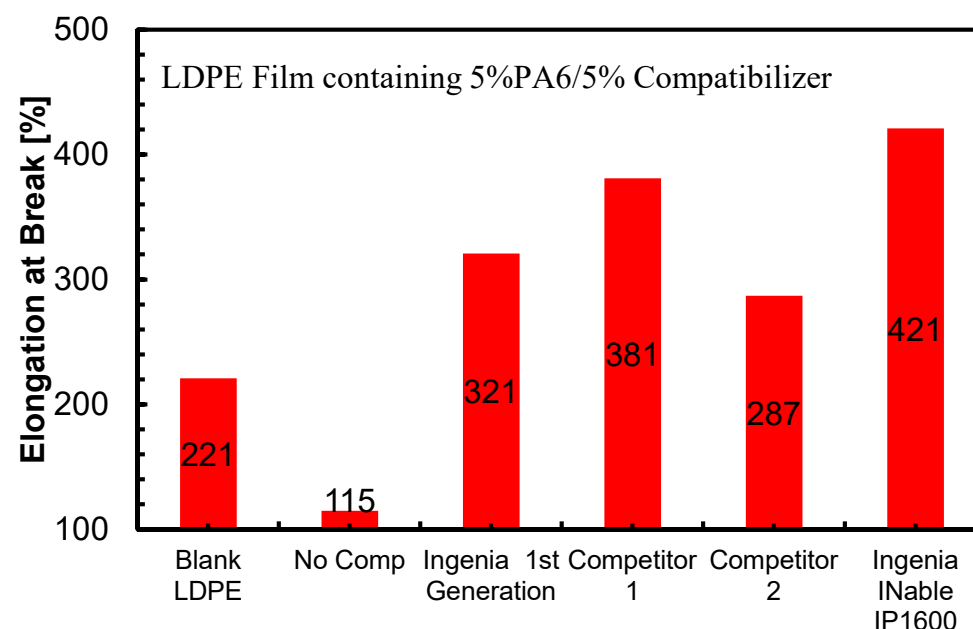
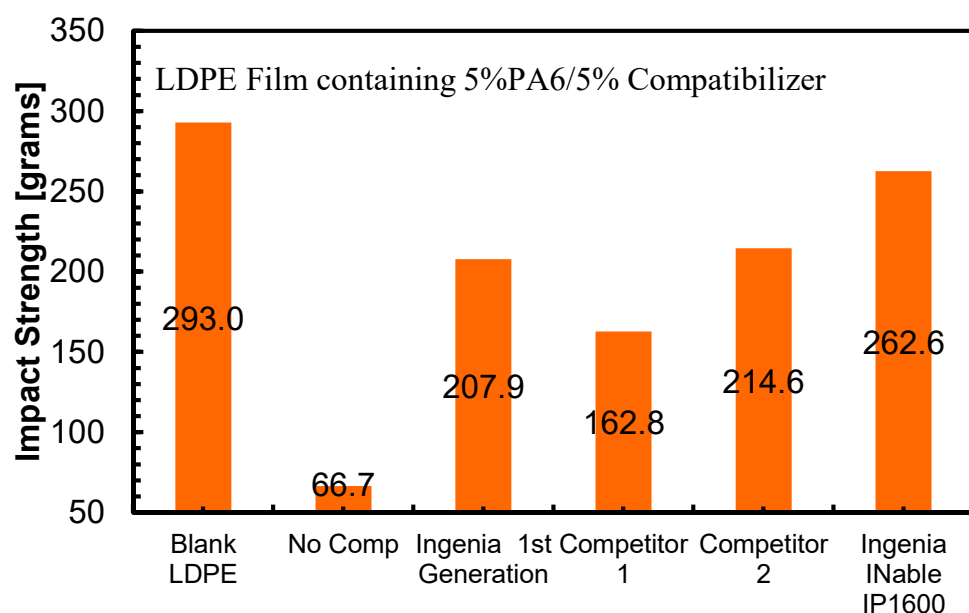


- Ingenia initial grade provides similar performance with competitors products for PE-EVOH System however **INGENIA INable IP1600** grade provides better performance.

Mechanical Properties



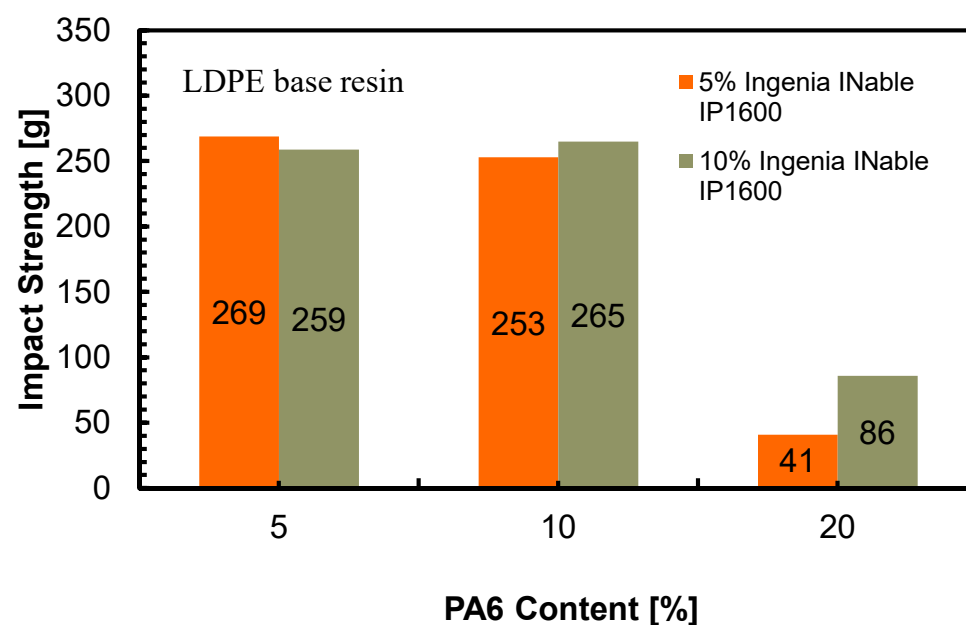
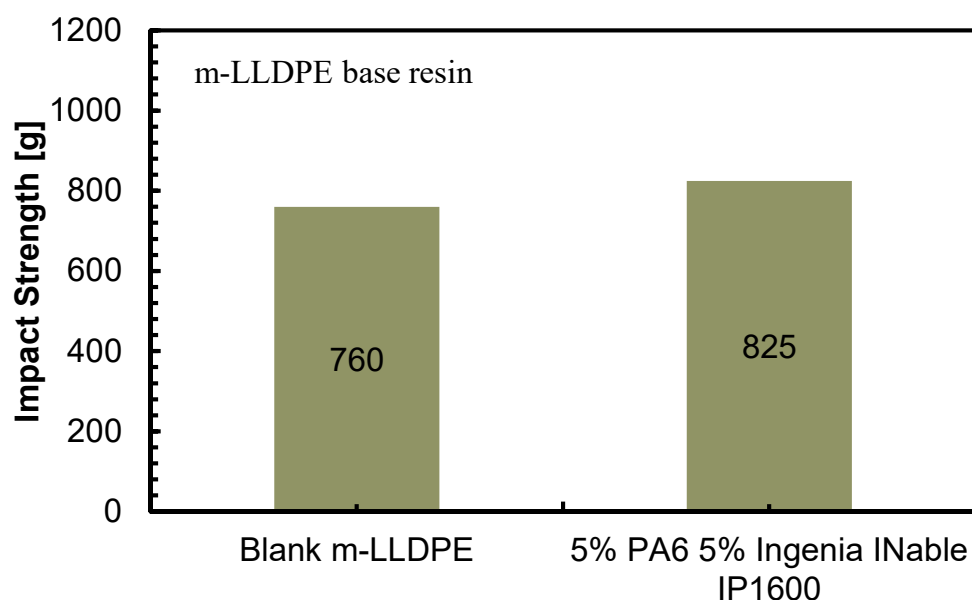
FOR PA6



- Ingenia initial grade provides similar performance with competitors products for PE-PA6 System however INGENIA **INable IP1600** grade has improved performance.

Mechanical Properties

FOR PA6

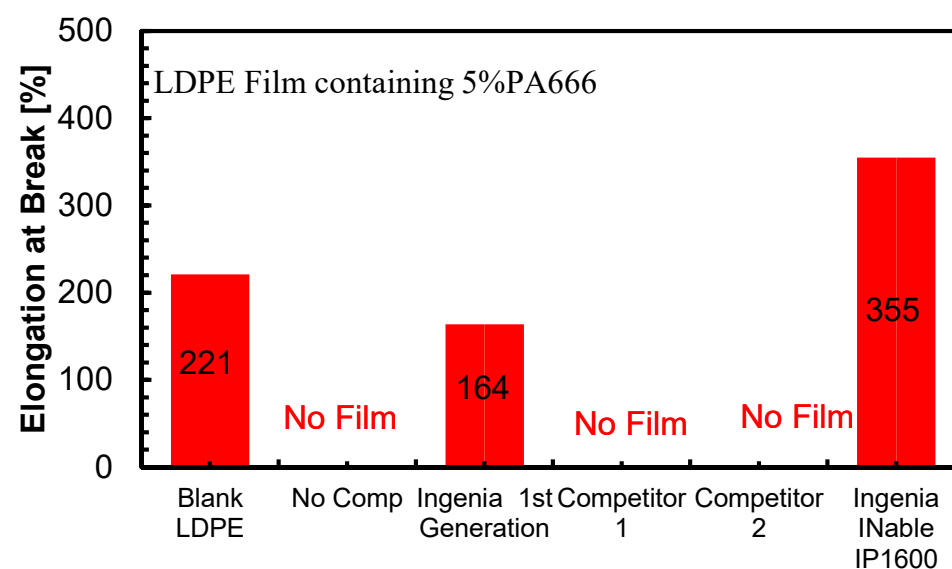
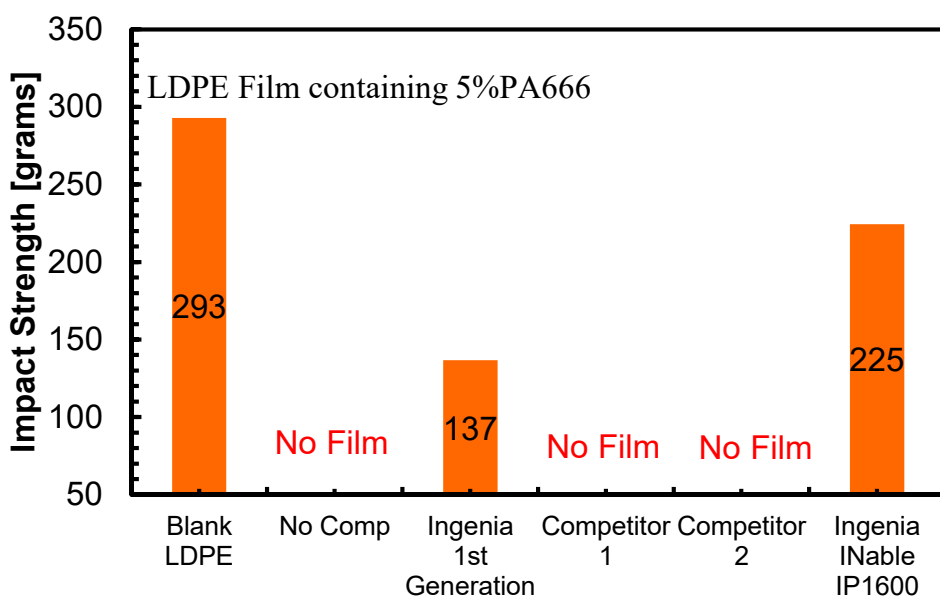


- INGENIA **INable IP1600** grade shows excellent impact strength retention at 5% LDR and up to 10% PA6 content. At 20% PA6 content the impact properties are diminished due to the inherent brittleness of PA6.

Mechanical Properties



FOR PA666

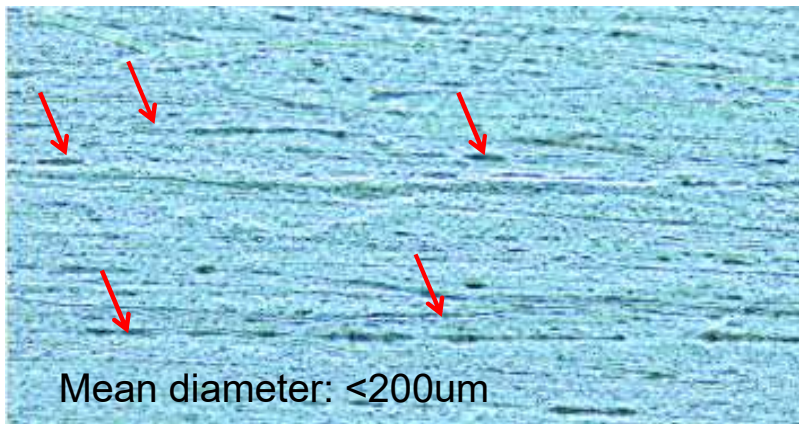


- None of the competitive products compatibilized the system to allow for film production (holes in bubble). Ingenia initial grade provides good performance for PE-PA666 system, however **INGENIA INable IP1600** grade provides superior results.

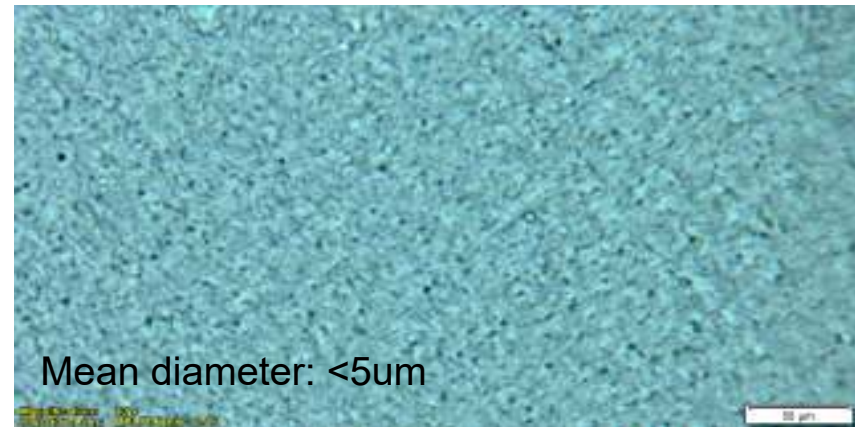
INGENIA INable Compatibilizer



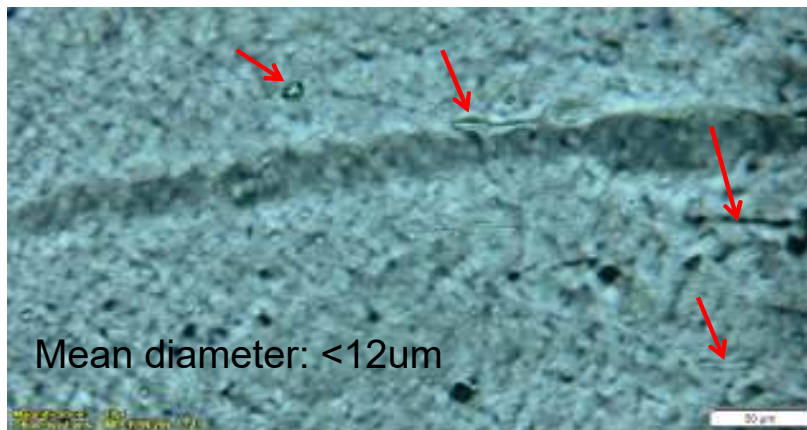
NO COMPATIBILIZER



With Ingenia INable IP1600



With Ingenia 1st Generation



- PE-Nylon system without compatibilizer exhibits large chunks of nylon inside PE matrix. This ruins physical properties.
- Competitors and Ingenia initial grade products show bi-continuous lamella like morphology.
- INGENIA **INable IP1600** grade provides well dispersed and distributed nylon particles along the PE matrix, providing superior film properties.

What are the applications for Ingenia INable IP1600 generation product?

- **Internal film plant recycling.** Film from edge trim, start-up and process interruptions can be recycled which contains EVOH, PA6 and PA666.
- **Ready to Recycle films.** Add Ingenia INable IP1600 generation product in its own layer so that it can be used as a compatibilizer for the film when the packaging item is captured at store drop off locations and enters the PE film recycling stream.
- **Upcycling!** For recycling companies to improve the properties of multi material product and hence the value of their repro pellets.



THANK YOU!
DO YOU HAVE ANY QUESTIONS?