



2006 PLACE Conference
September 17-21
Cincinnati, Ohio

Improving Optical Clarity of Polyethylene Blown Films

by Kam Ho and Joo Teh

Presented by:

Kam Ho



Outline

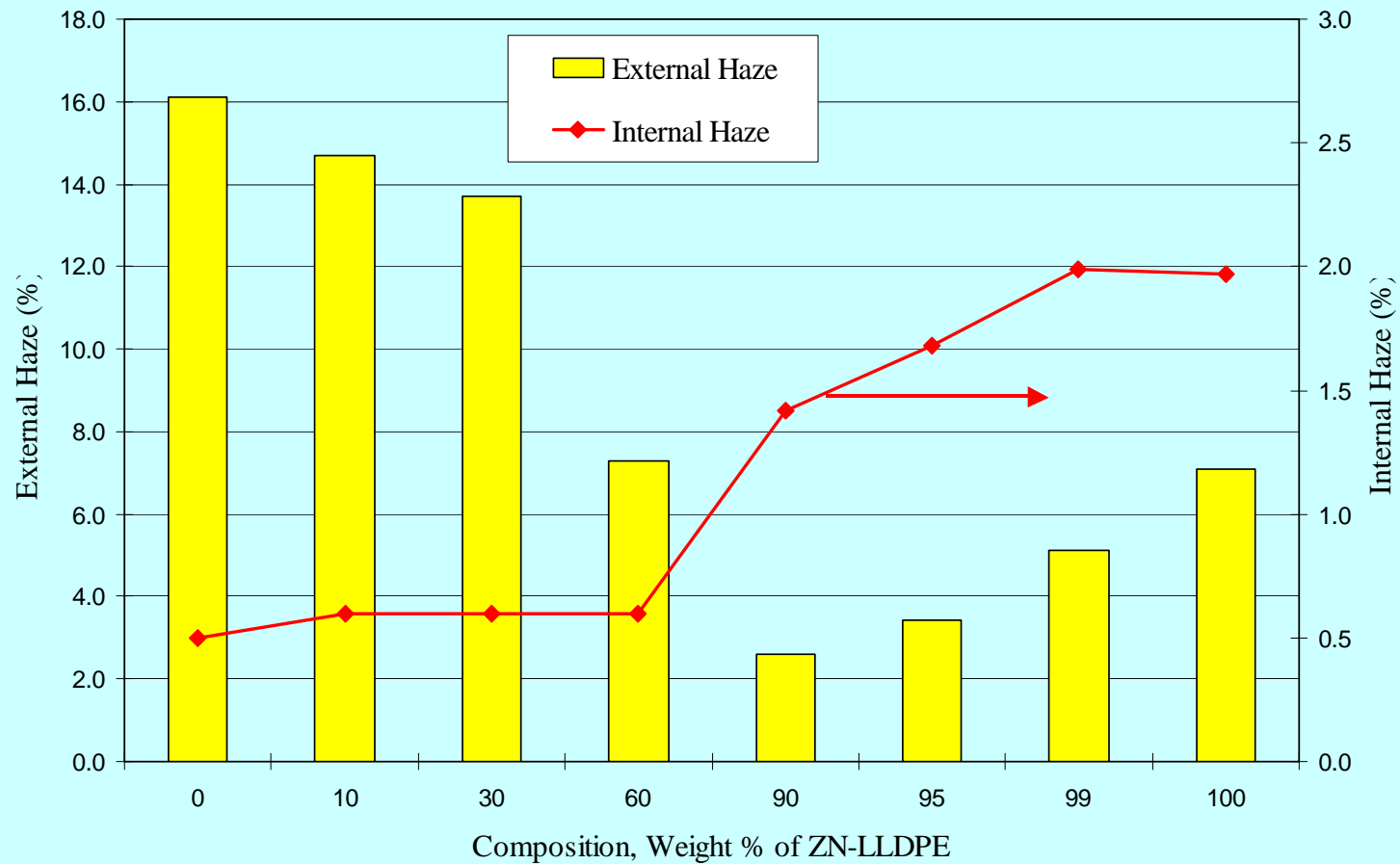
- **Background**
- **Resins and Optical Properties**
- **Internal Haze**
- **External Haze**
- **Conclusions**
- **Acknowledgement**

Resins Table

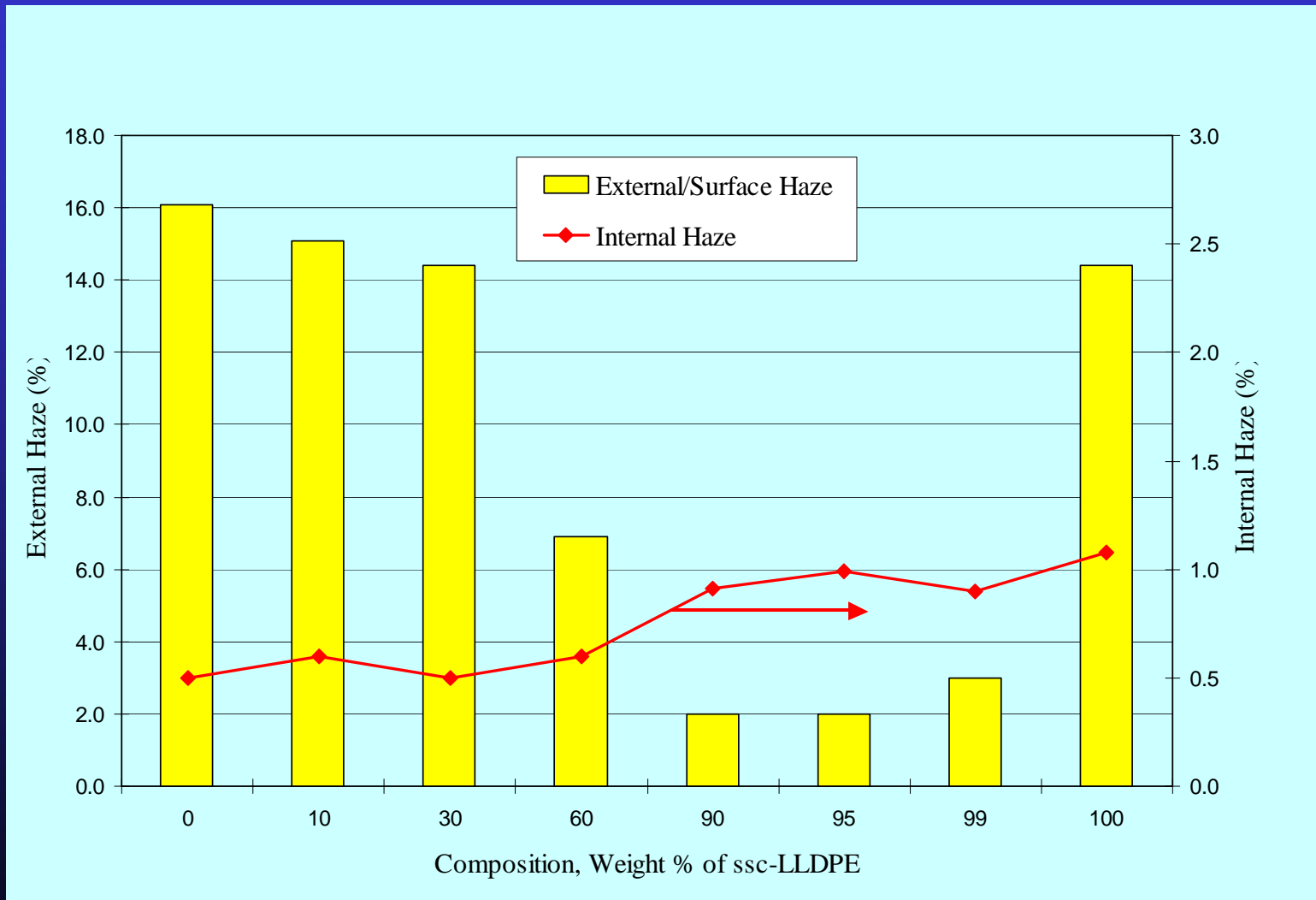
	Density	Melt Index
ZN-LLDPE	0.920	1.0
ssc-LLDPE	0.917	1.0
LF-0219A*	0.918	2.3

** This is a tubular LDPE from NOVA Chemicals.*

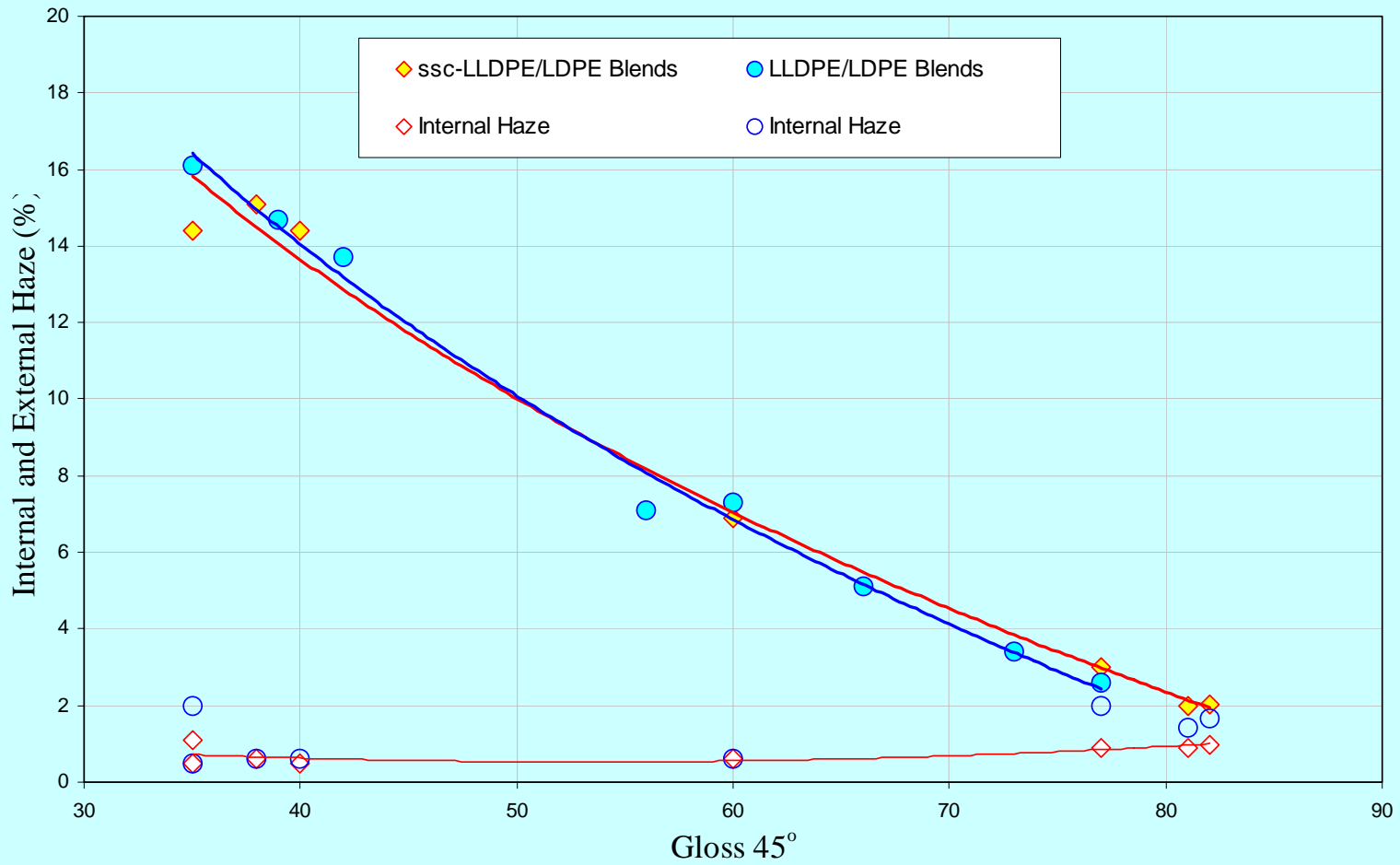
Haze of ZN-LLDPE and LDPE Blends



Haze of ssc-LLDPE and LDPE Blends



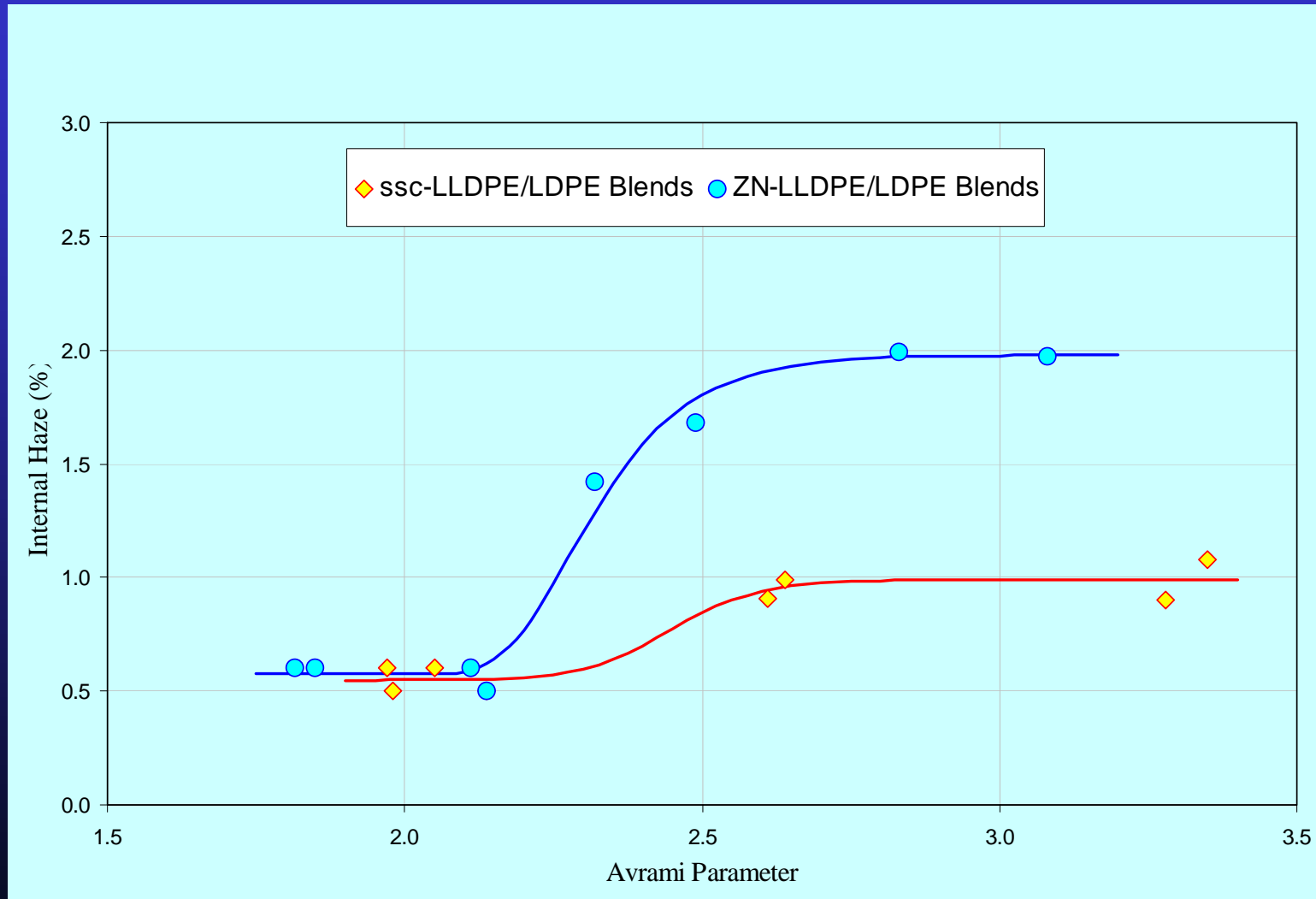
Haze vs Gloss



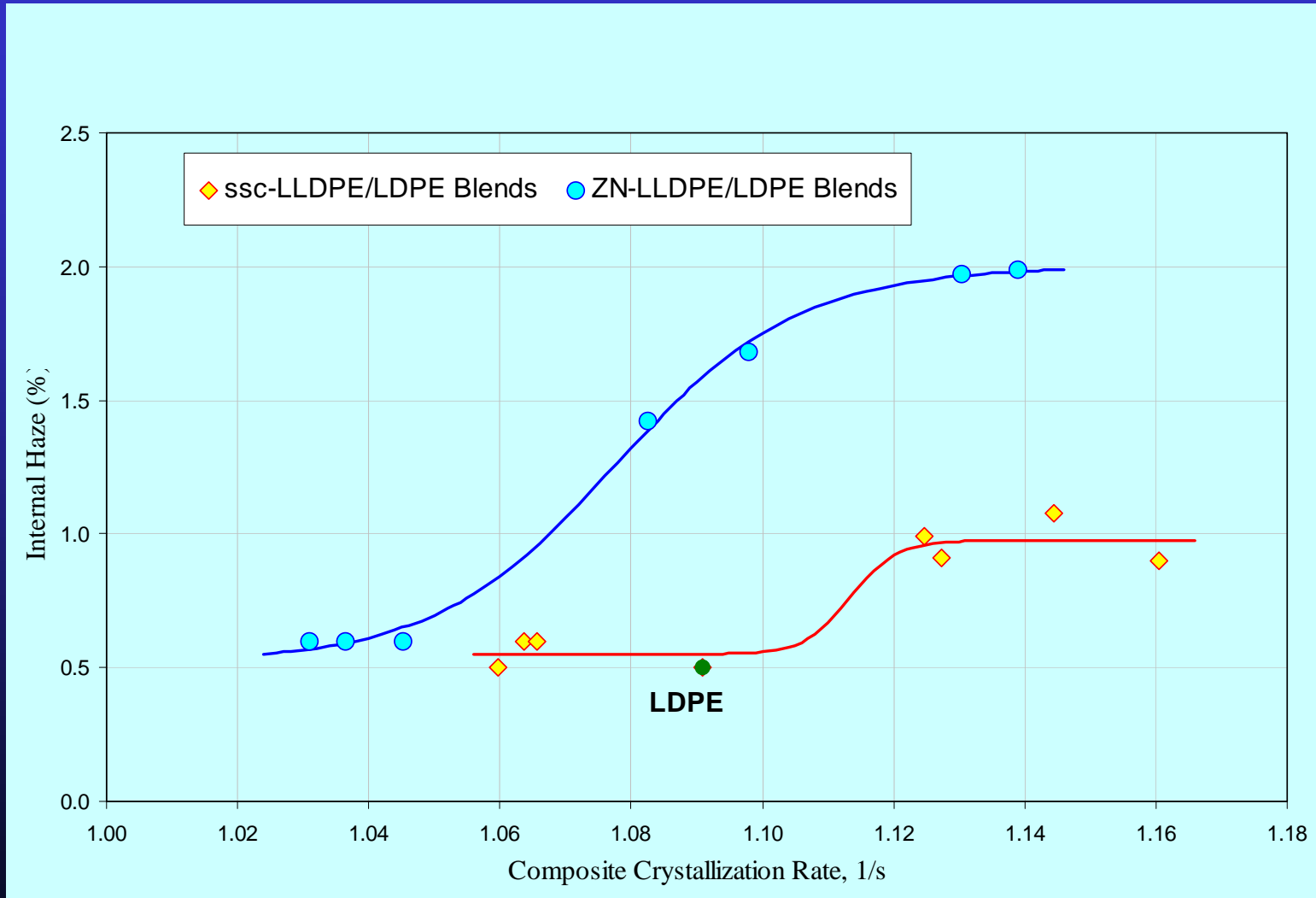
Summary of Observations

- The Total Haze of blown films is dominated by the External Haze.
- External Haze correlates well with Gloss.
- External Haze and Internal Haze relate to the blend composition differently.

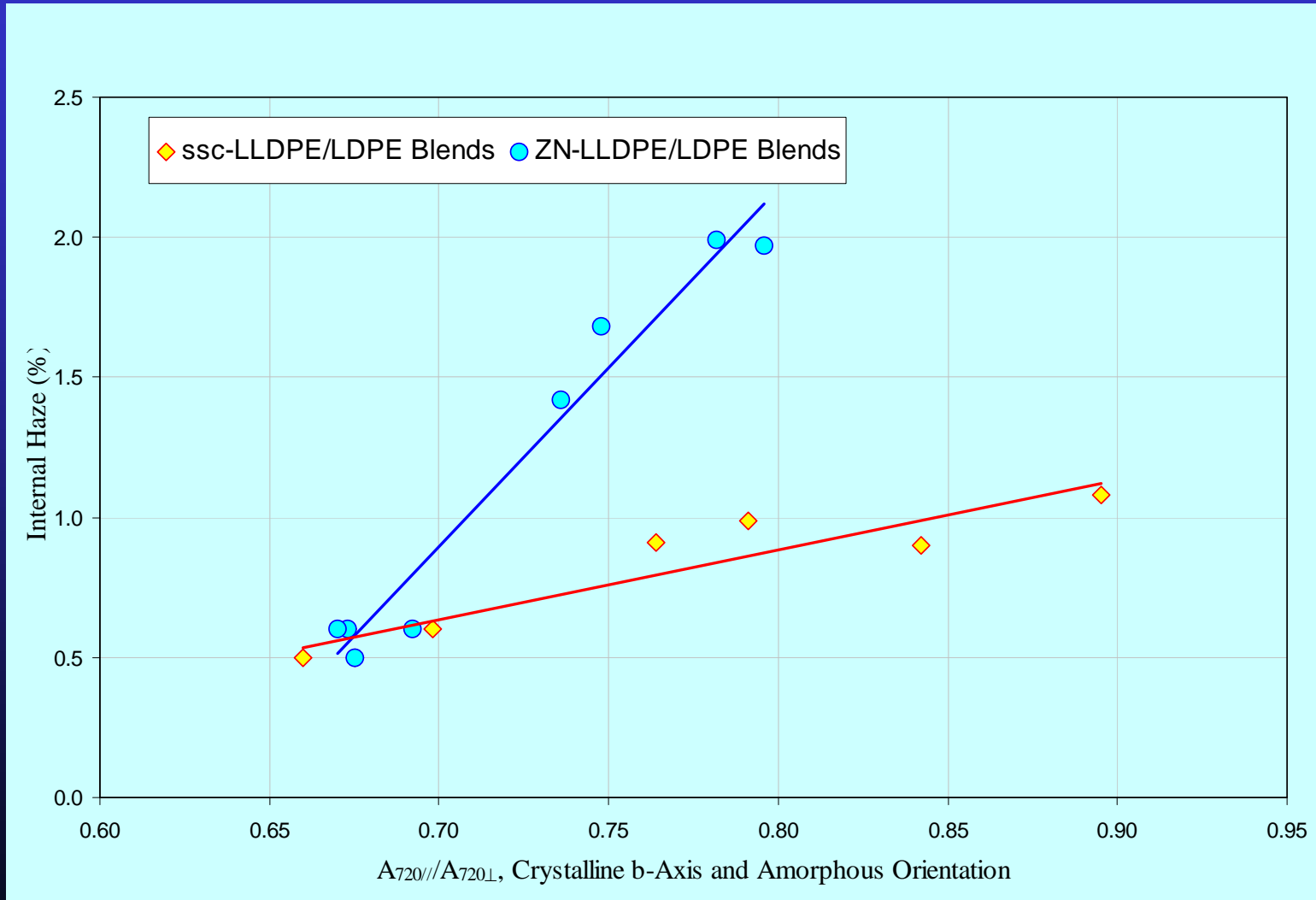
Internal Haze vs Avrami Parameter



Internal Haze vs Composite Crystallization Rate



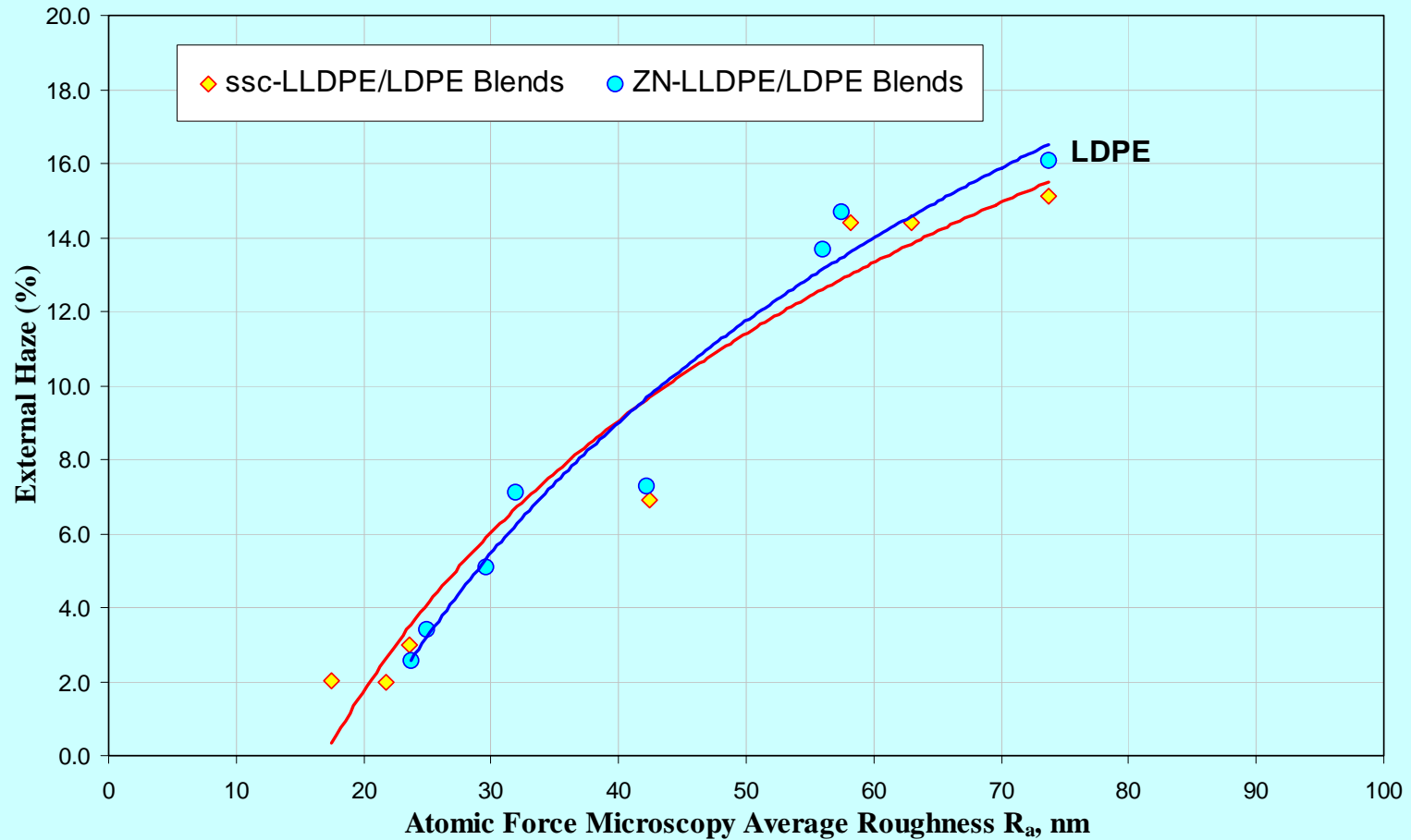
Internal Haze vs Bulk b-Axis Orientation



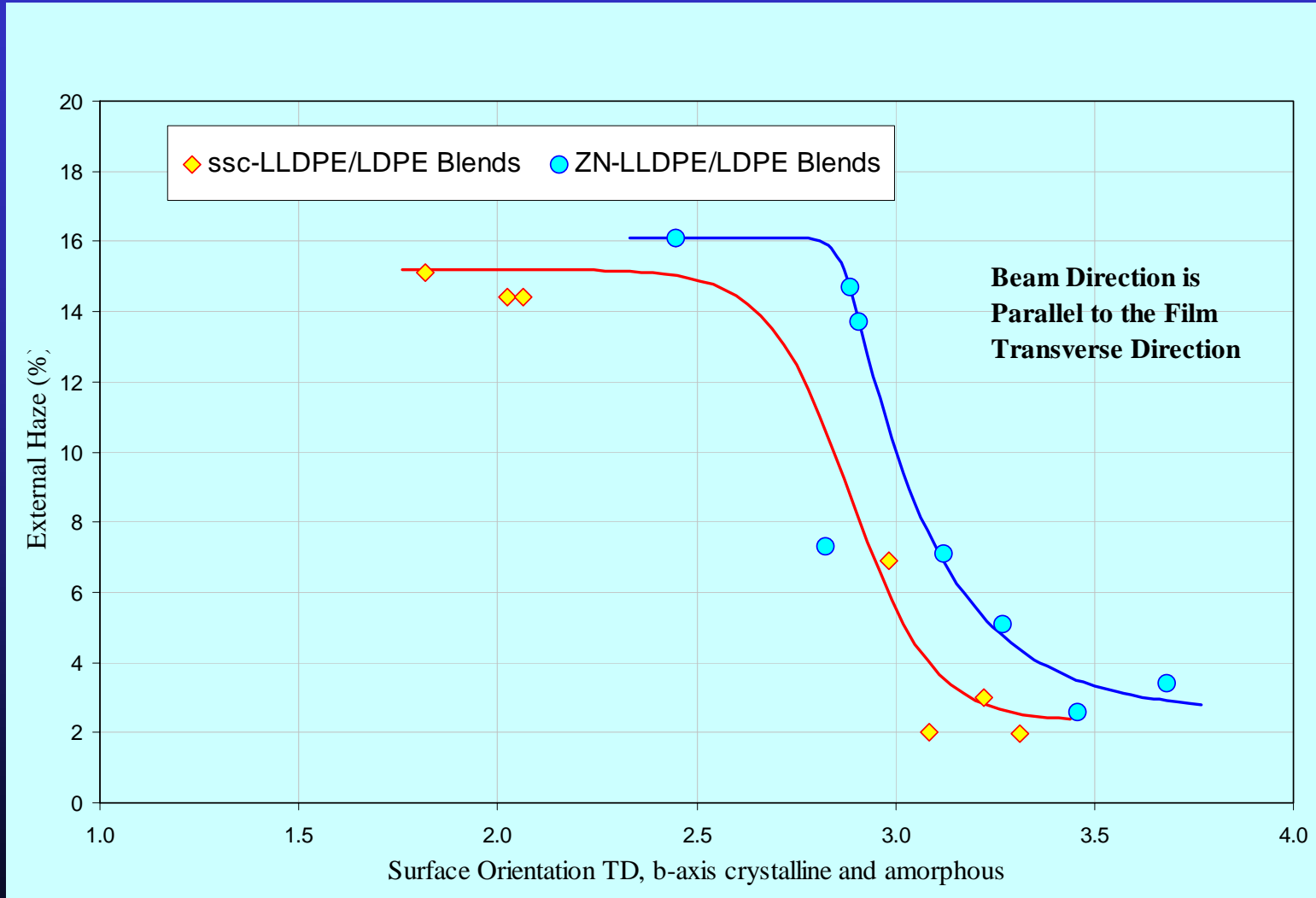
Summary of Observations

- Internal Haze varies systematically with the bulk crystallization behavior and bulk orientation of crystallites.
- The variation of internal haze of Single-site catalyzed LLDPE demonstrates different patterns than the Ziegler-Natta catalyzed LLDPE.

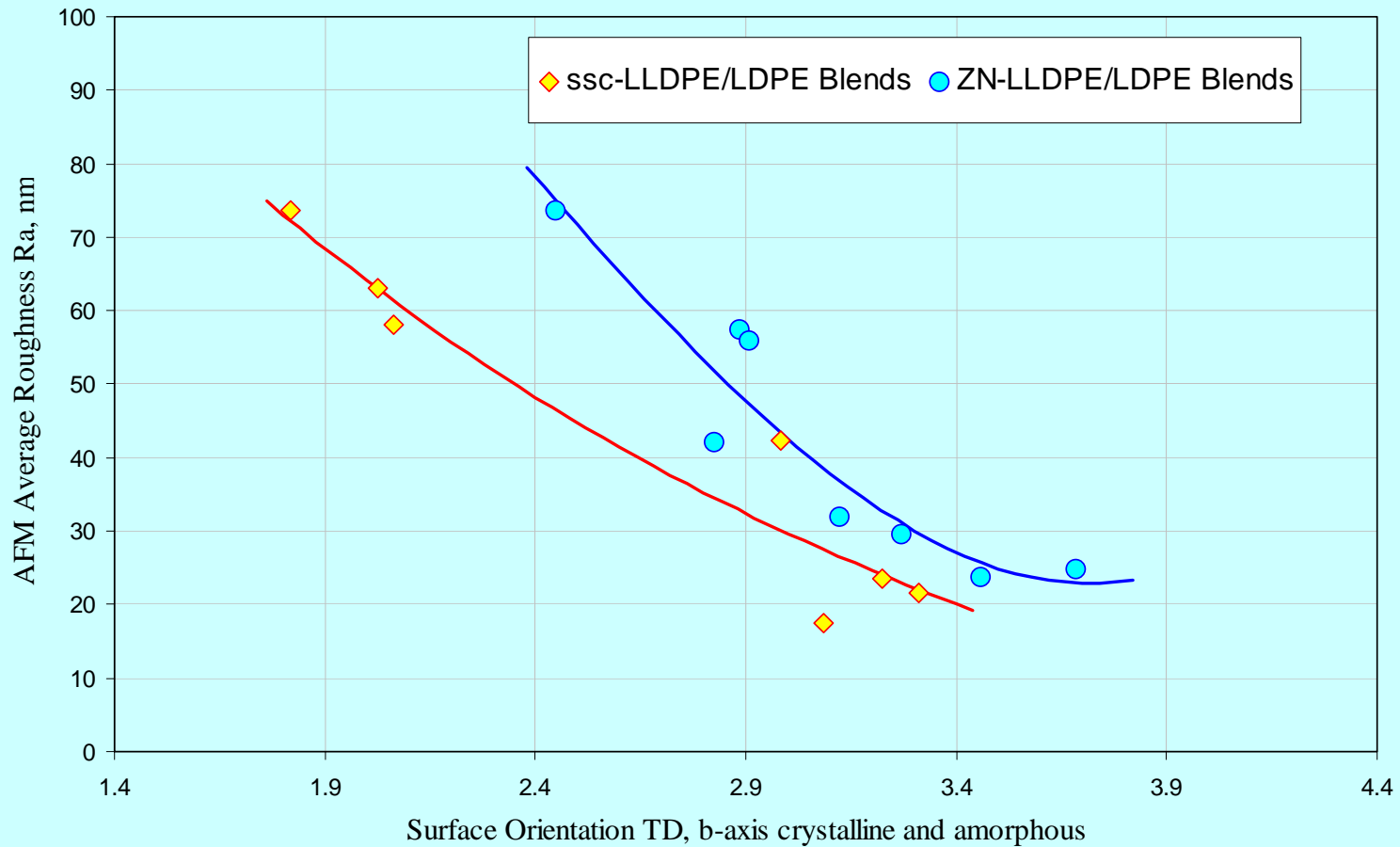
External Haze vs Surface Roughness



External Haze vs Surface b-Axis Orientation - TD



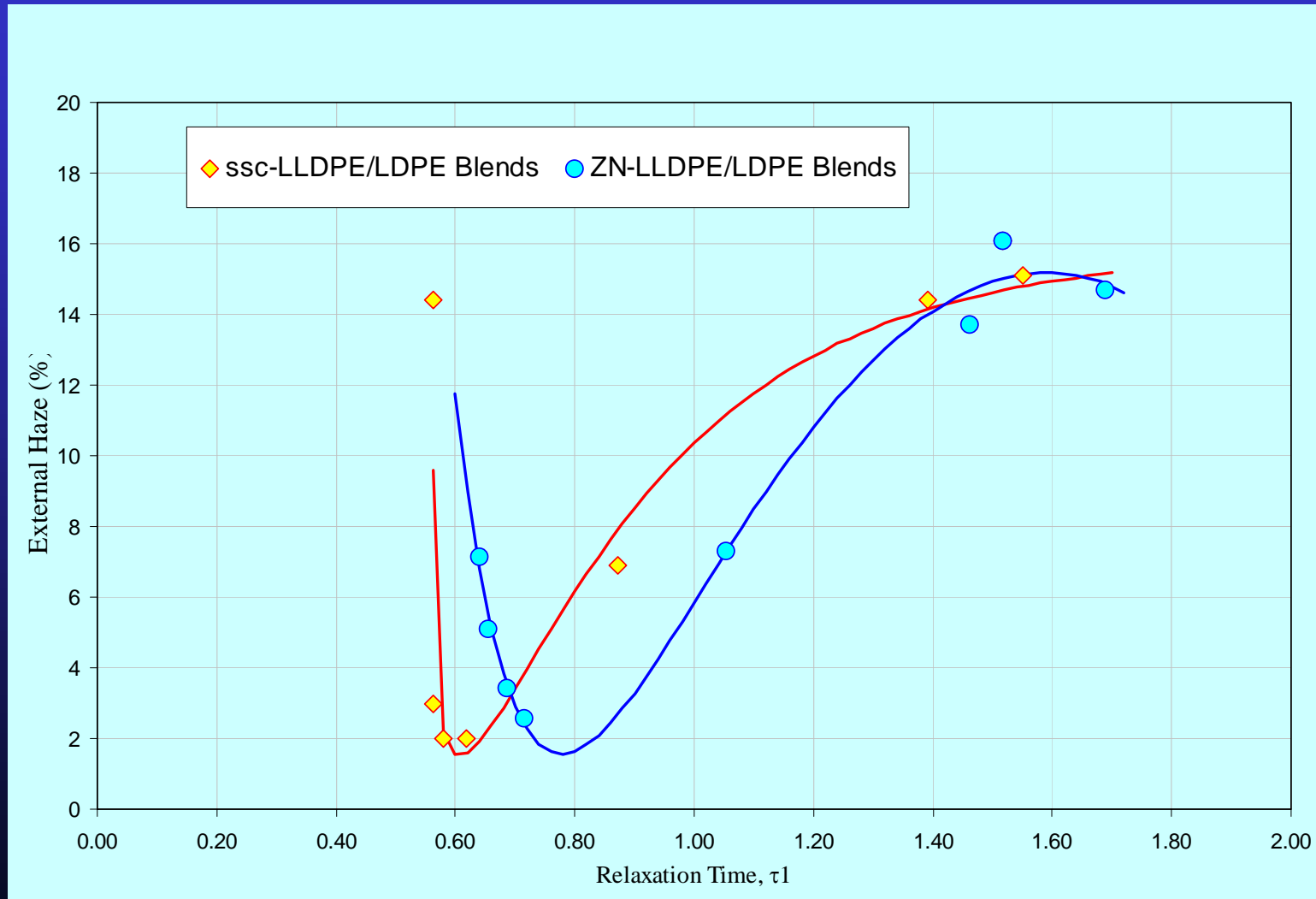
Surface Roughness vs Surface b-Axis Orientation - TD



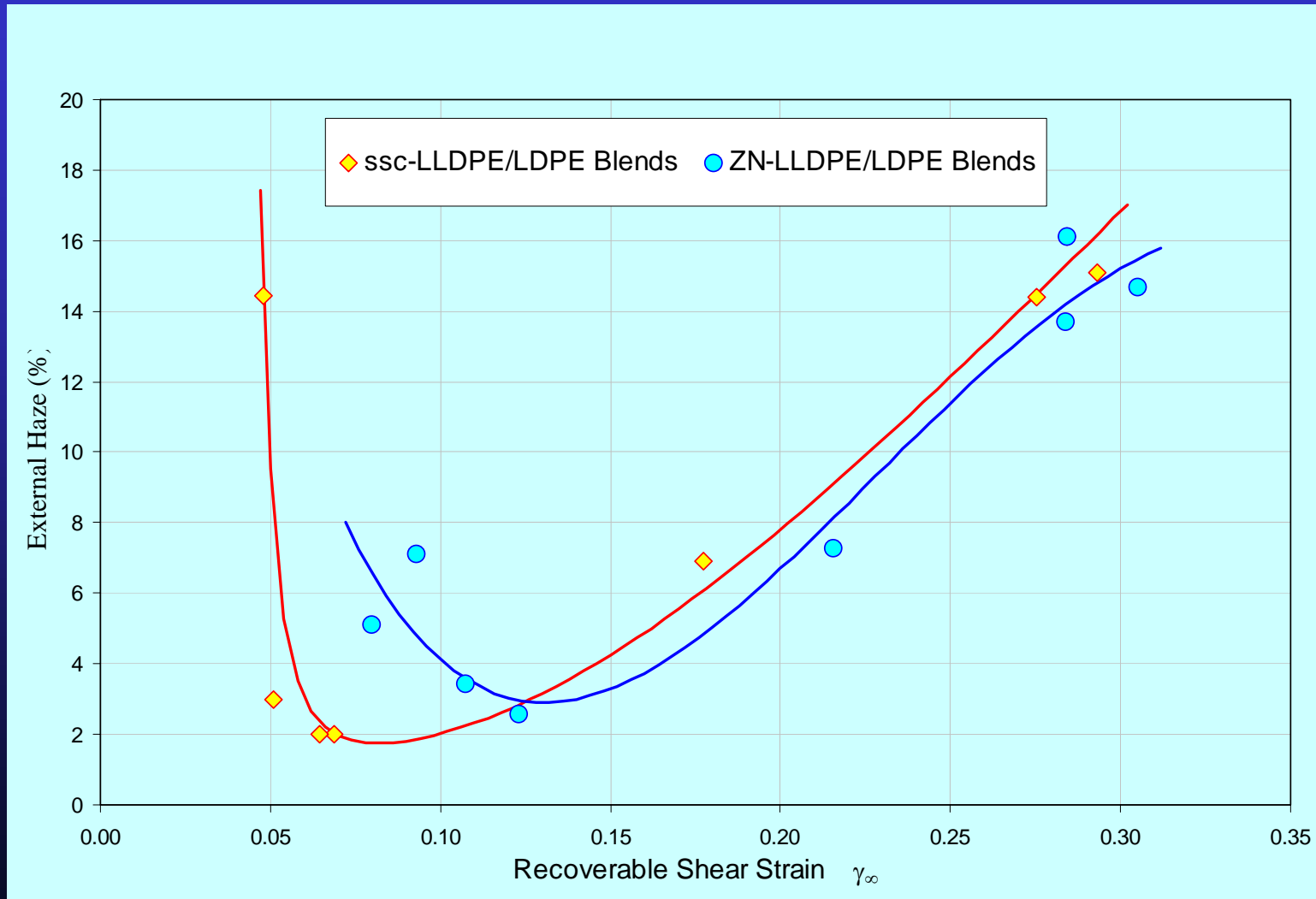
Summary of Observations

- External Haze is controlled by Surface Morphology – roughness and orientation of crystallites.
- Surface roughness and orientation of crystallites are inter-related.

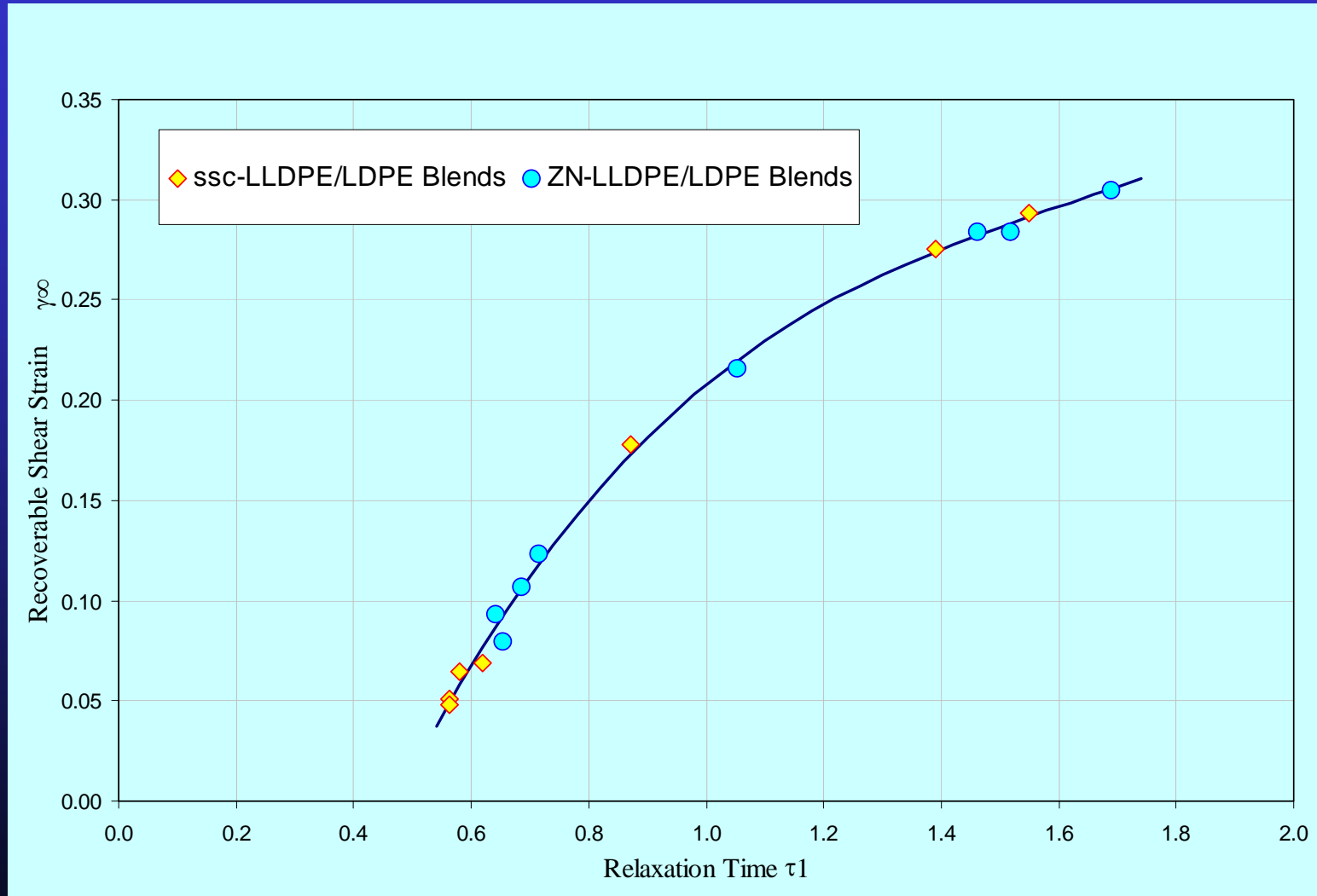
External Haze vs Melt Relaxation Time, τ_1



External Haze vs Recoverable Shear Strain



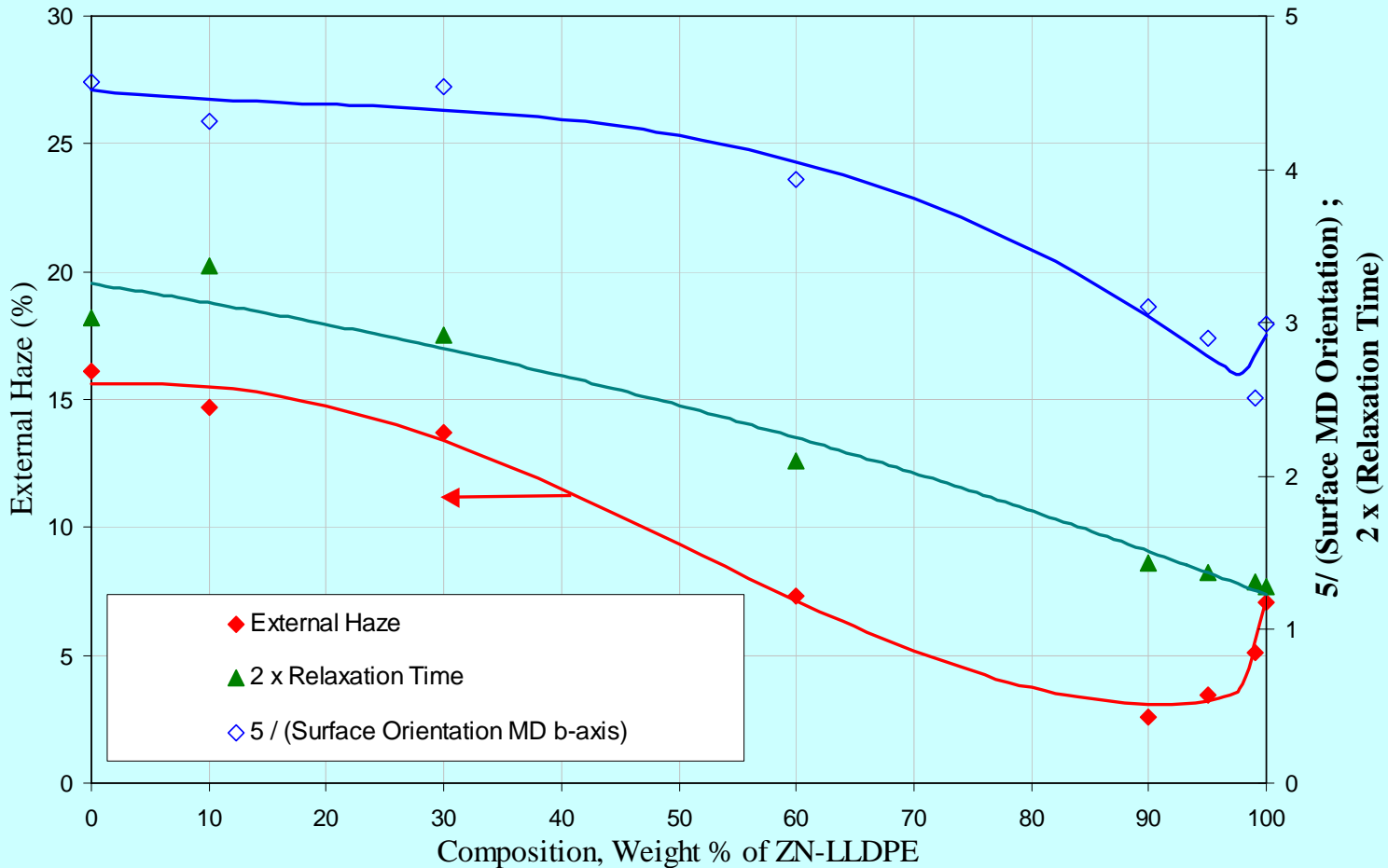
Melt Relaxation Time vs Recoverable Shear Strain



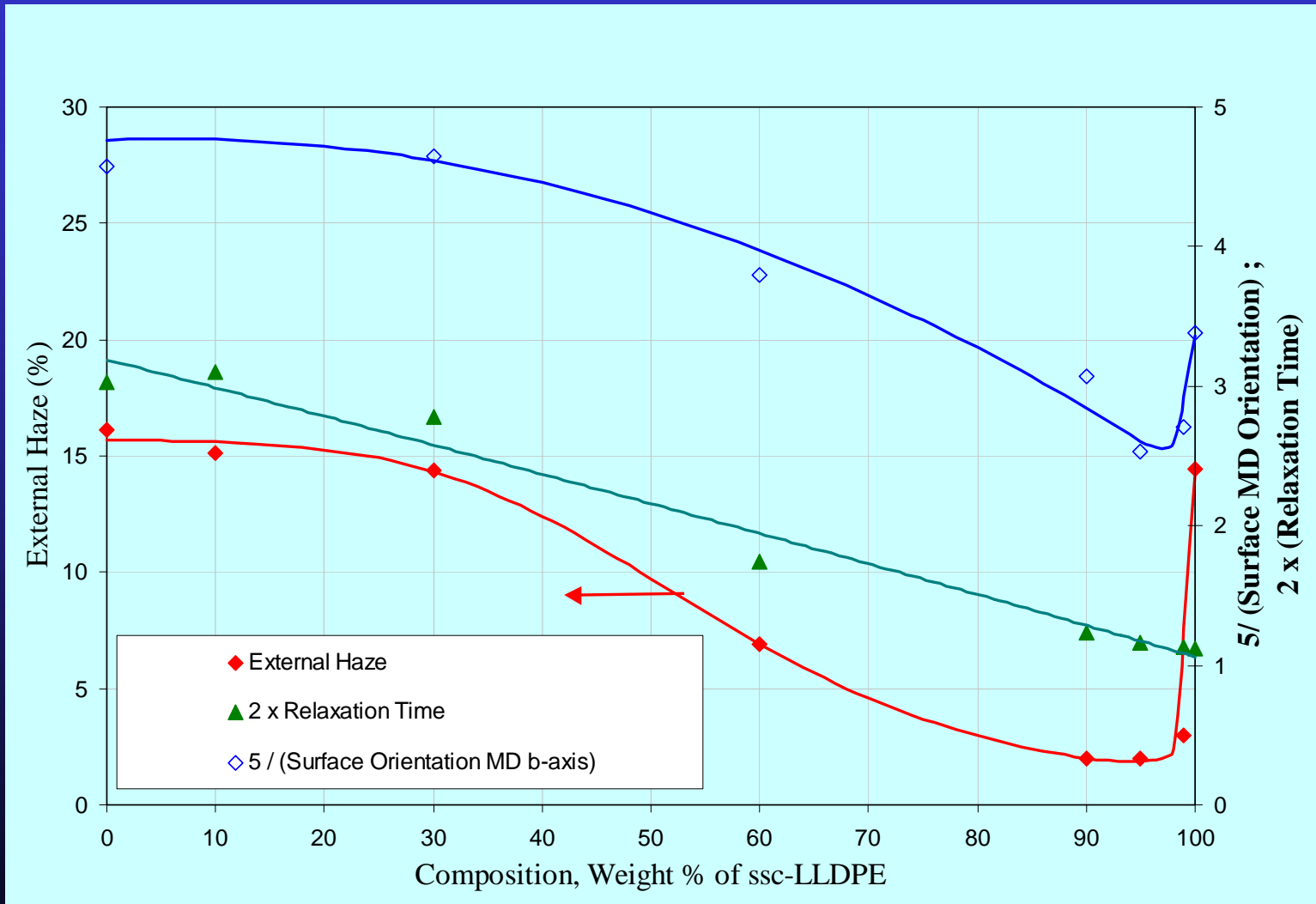
Summary of Observations

- External Haze is controlled by the melt rheology of polyethylene.
- Melt Relaxation Time is more fundamental than Recoverable Shear Strain in relationship to optics of films.

External Haze and Other Variables vs ZN-LLDPE/LDPE Composition



External Haze and Other Variables vs ssc-LLDPE/LDPE Composition



Conclusions

- A method using ATR-FTIR coupled with a polarizer has been developed to examine the orientation of crystallite on film surface.
- The overall haze of blown films is dominated by the external haze arising from surface structure.
- The optical properties of blown films have been shown related to the surface roughness and the crystallite orientation on film surface.

Conclusions (continued)

- Addition of a tubular LDPE even at 1 wt% can significantly improve the optical properties of LLDPE films.
- The relaxation time and crystallization behavior of the melt are believed to be the key parameters controlling the optical properties of blown films.

Thanks to ...

- TAPPI for this opportunity to present the results of our study.
- NOVA Chemicals Corporation for the support and permission to the publication of this paper.
- Our colleagues in the Analytical Group and Plastic Technology Lab at NOVA Chemicals for film blowing and testing.

Thank You

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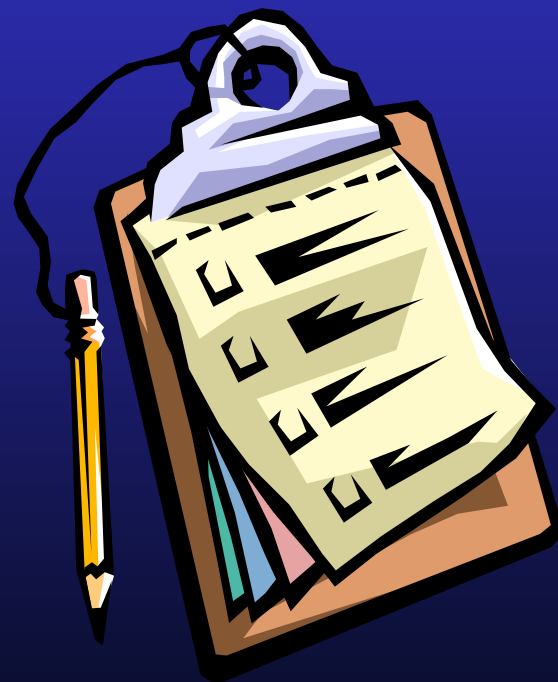
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sheet...*