New Thermo-opaque Smart Plastics

Dr. Chris DeArmitt – Phantom Plastics™

- **Who are Phantom Plastics?**

- **Our history of new smart materials**

- **Introduction to styrenic polymers**

- **What is this new polymer?**

- **What effects does it display?**

- **How does it work?**

- **Is it a viable material?**

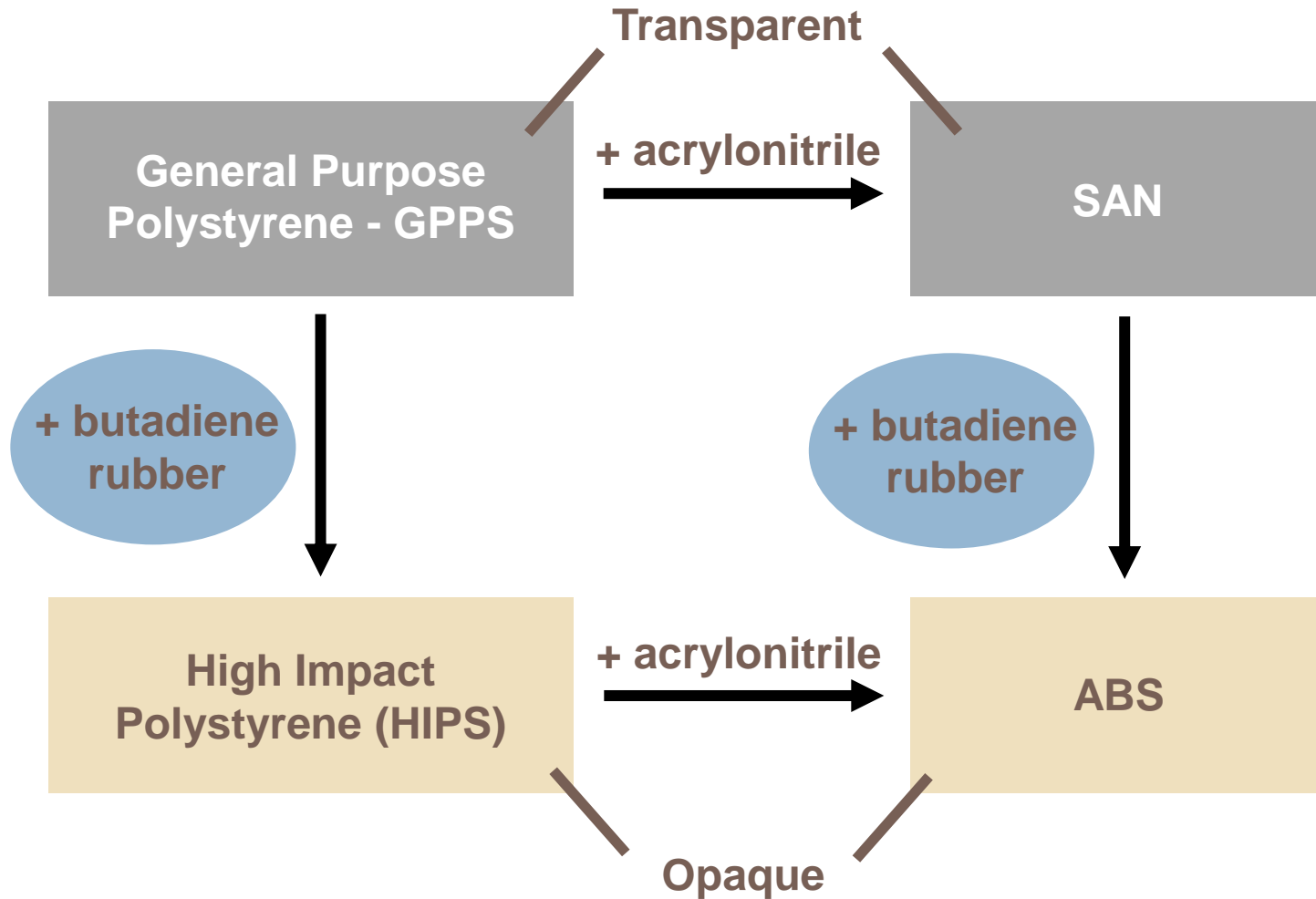- **Production and supply**

- **Summary**

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- **Phantom Plastics™:**

  - New plastic materials and formulations (fillers, antioxidants and specialty additives)

  - Problem solving

  - Training seminars, webinars, documents and video downloads
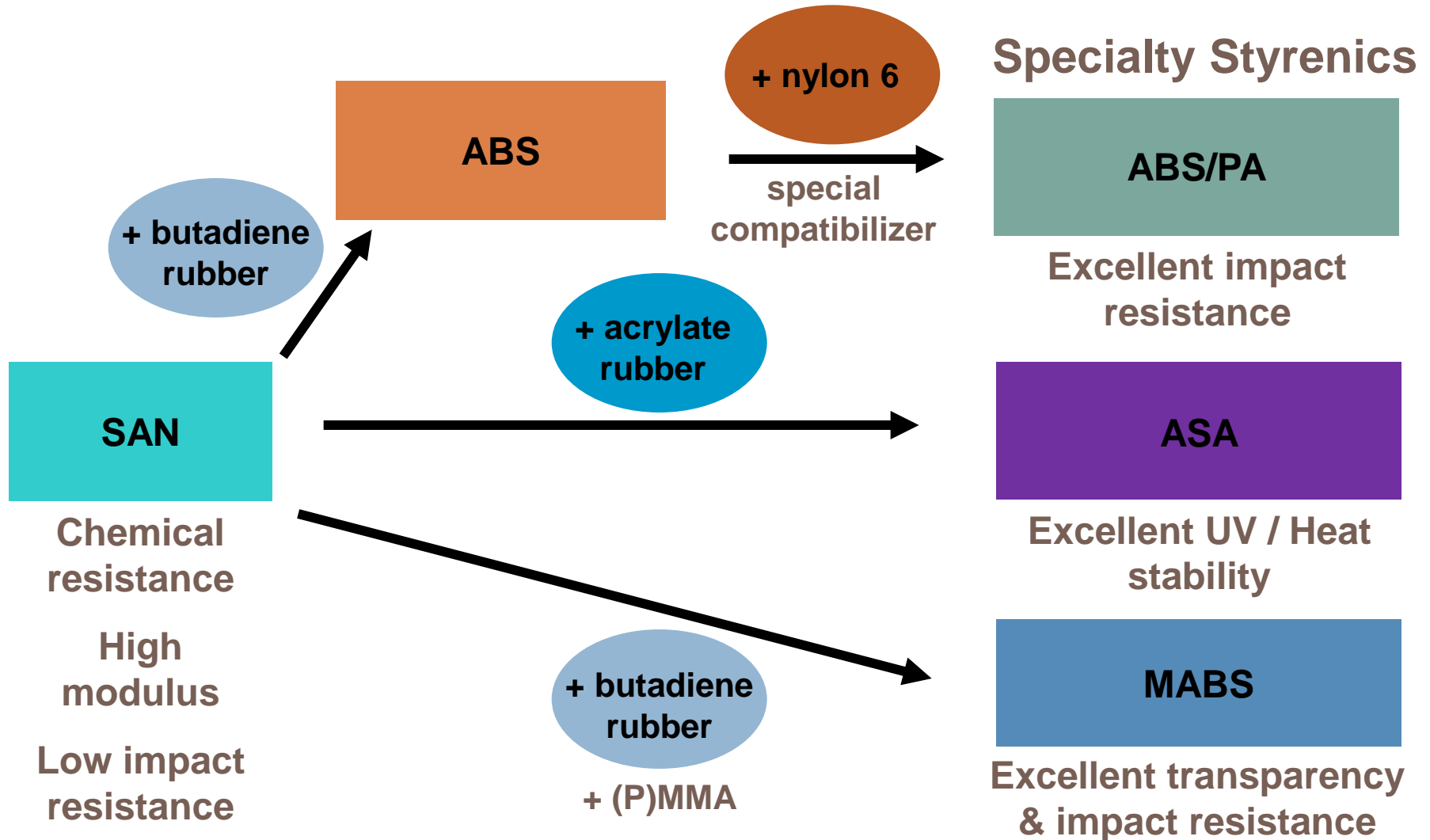
  - Smart materials creation

- **Smart materials history**

  - Developed a new water-soluble, self-doped polyaniline with new green to red colour switching with pH change

  - At BASF developed and patented new Smart Salts technology to solve a long-standing and serious product quality issue with ABS, ASA and MABS (BASF had spent 30 years and several million Euros and failed to solve the problem)

  - Developed, patented and marketing ThermoShift™ opacity changing thermoplastic

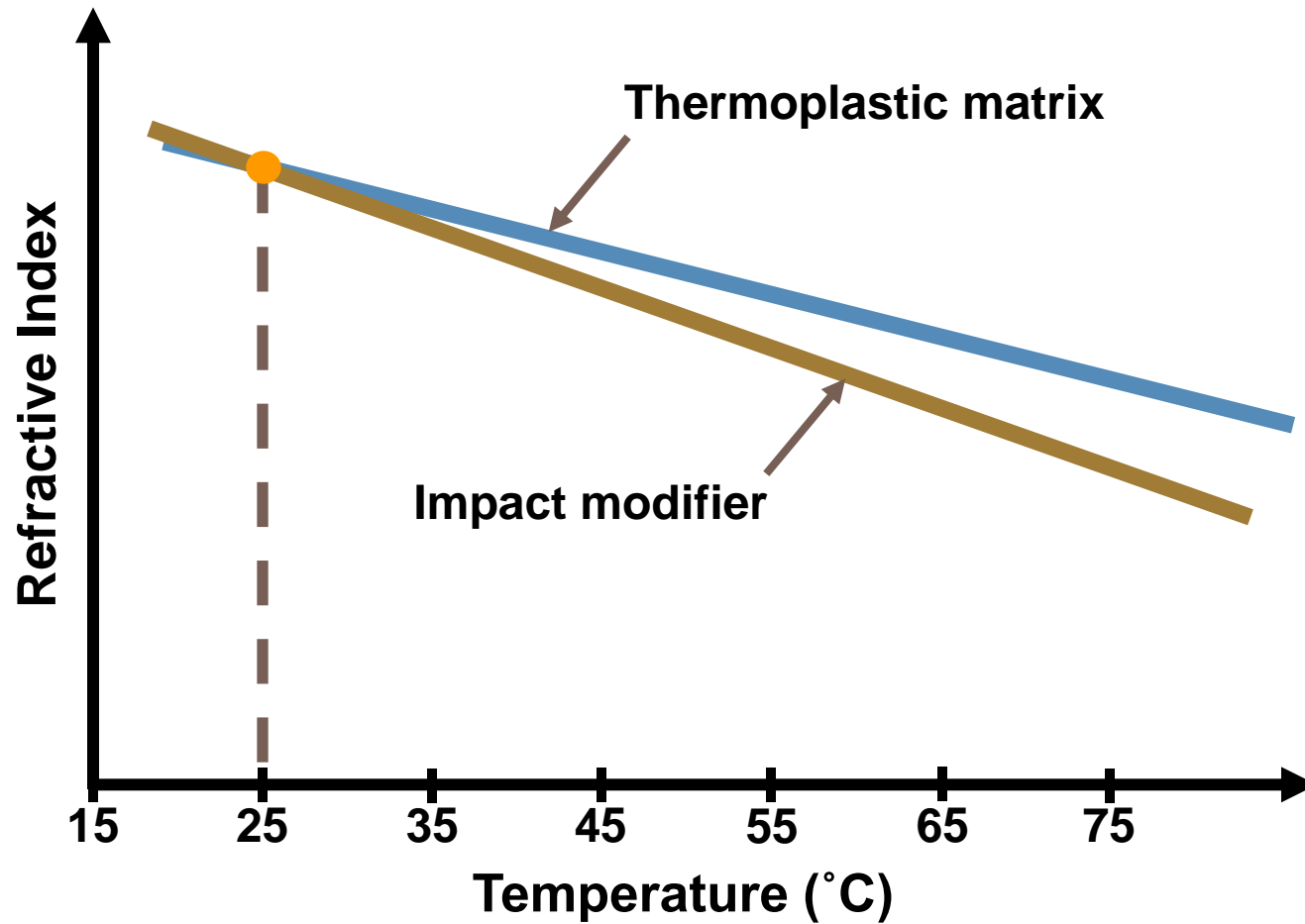 - Working with Fortune 100 company to develop a new type of smart packaging
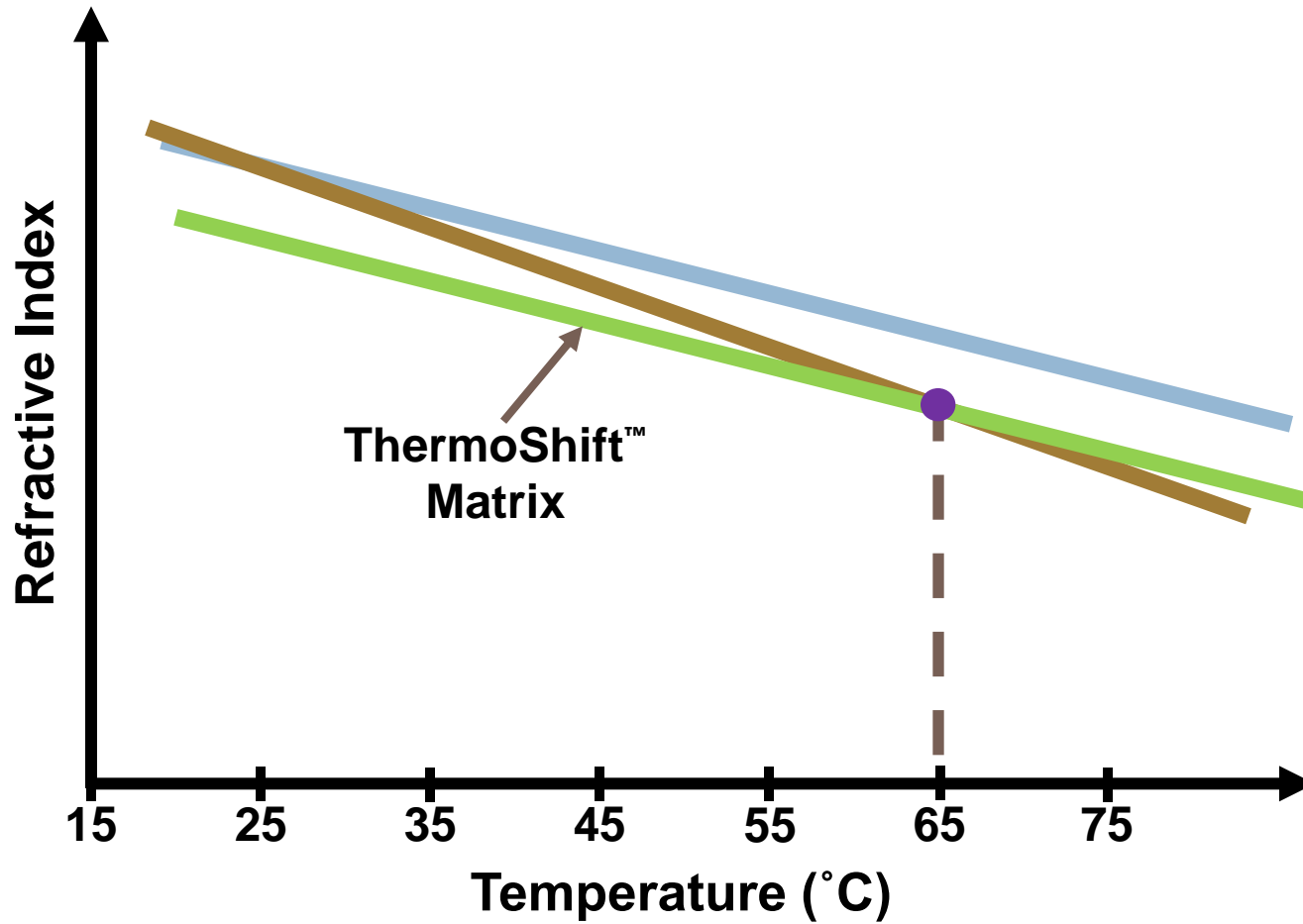
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Commodity Styrenic Polymers

Transparent

| General Purpose Polystyrene - GPPS | **+ acrylonitrile** → | SAN |

+ butadiene rubber

+ butadiene rubber

| High Impact Polystyrene (HIPS) | **+ acrylonitrile** → | ABS |

Opaque

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Specialty Styrenic Polymers

ABS

+ nylon 6

Specialty Styrenics

special compatibilizer

ABS/PA

Excellent impact resistance

+ butadiene rubber

SAN

Chemical resistance

High modulus

Low impact resistance

+ acrylate rubber

ASA

Excellent UV / Heat stability

+ butadiene rubber

+ (P)MMA

MABS

Excellent transparency & impact resistance

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MABS (transparent ABS)
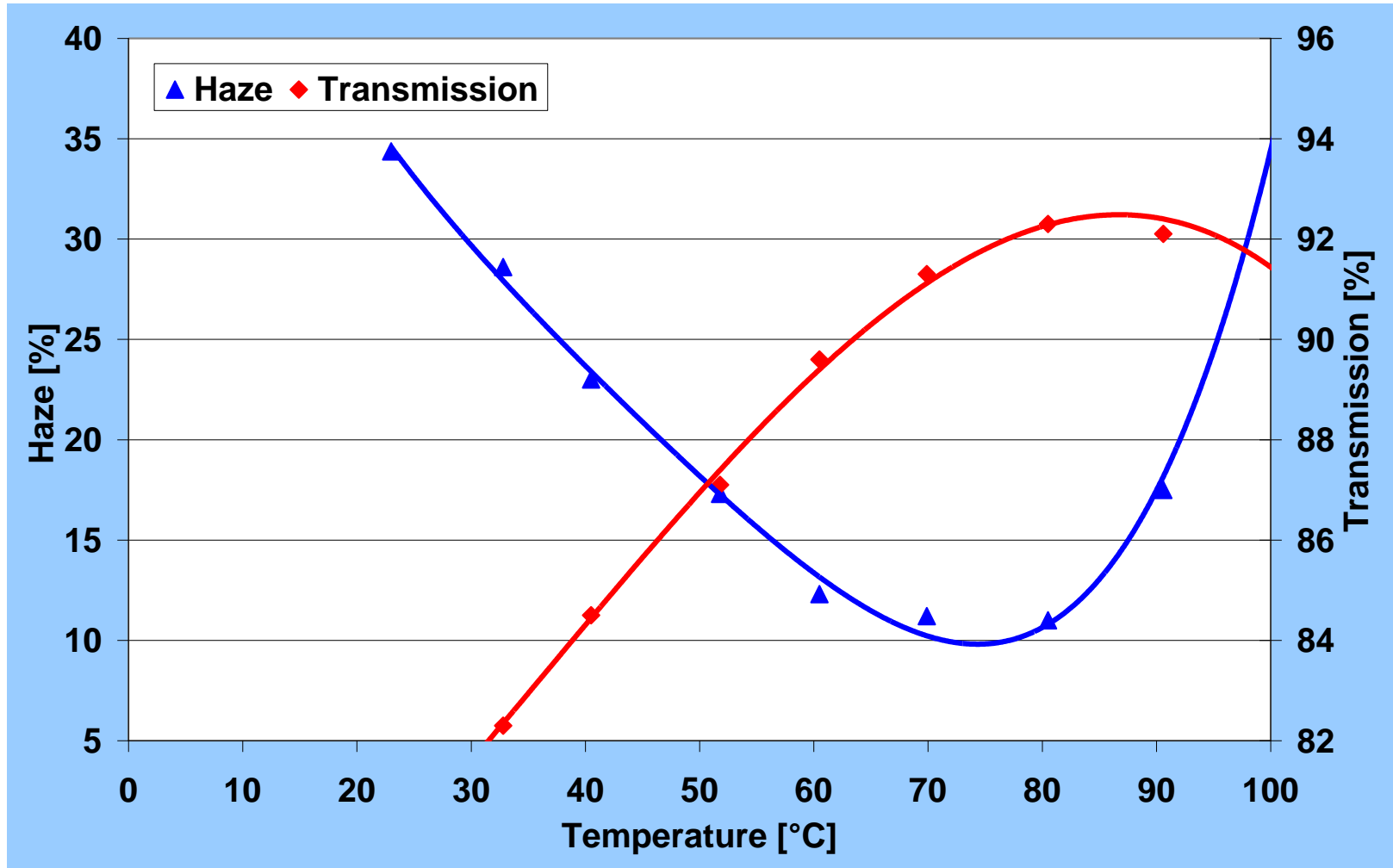
ThermoShift™

Optimised for 40°C (ASTM D1003)
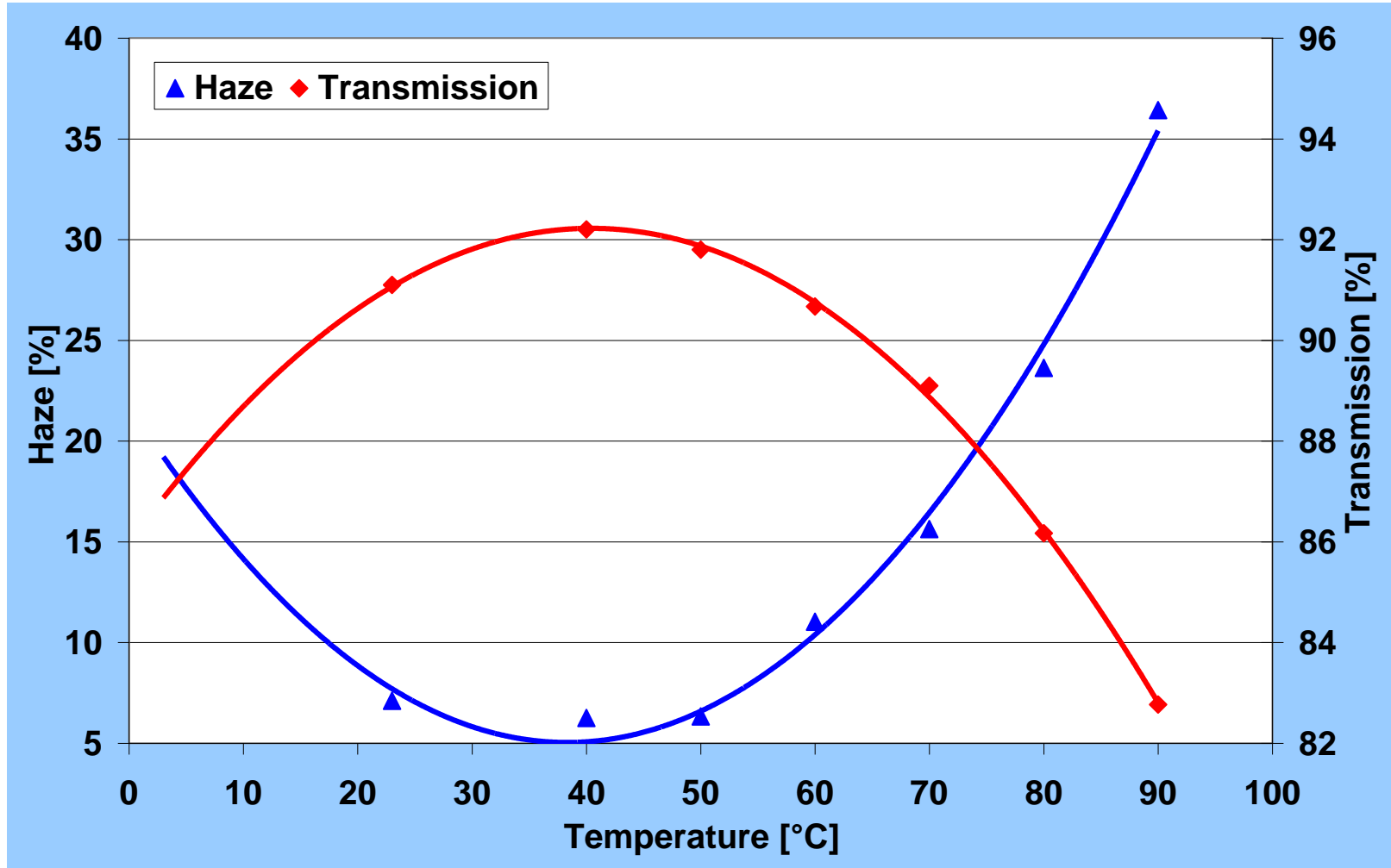
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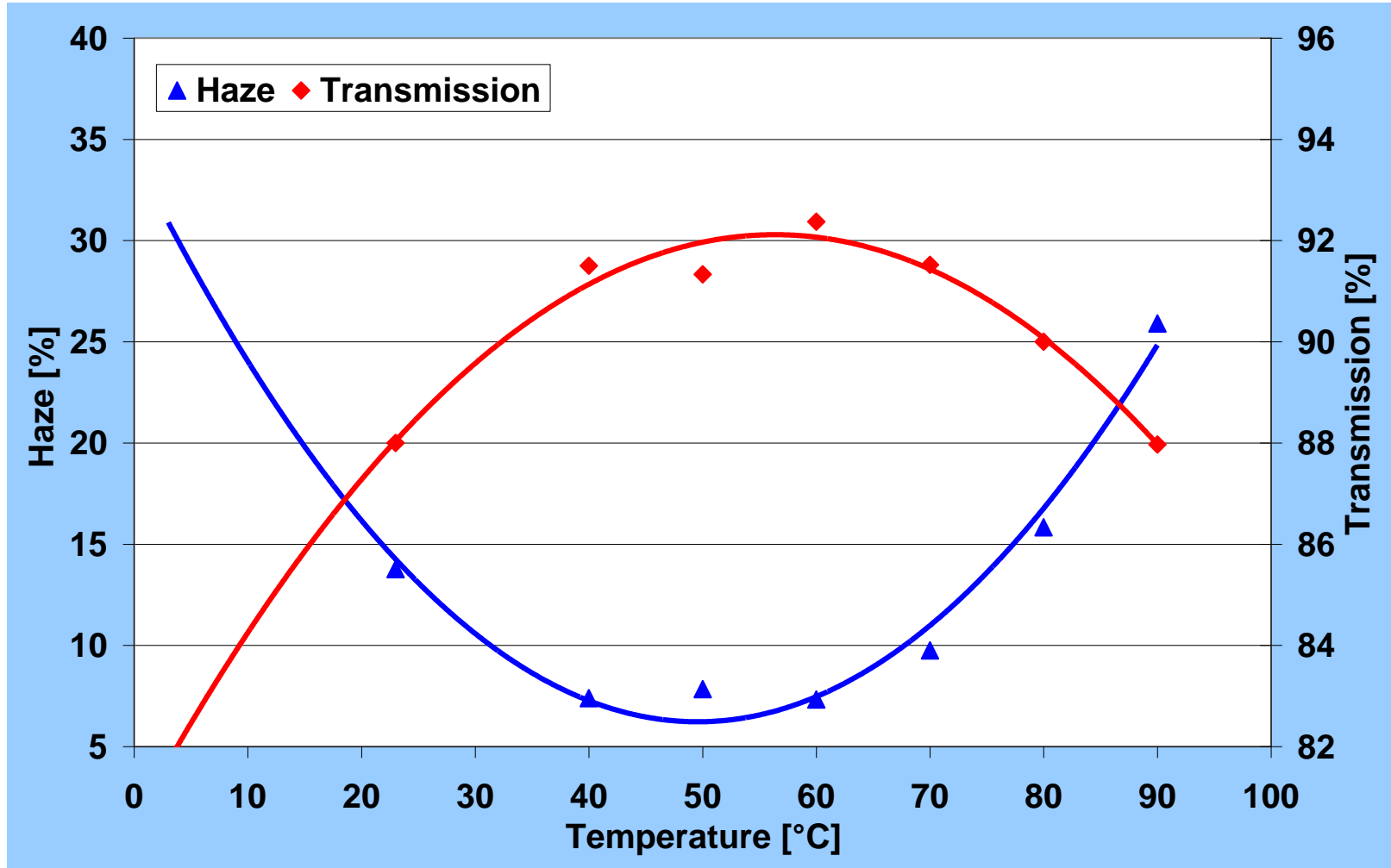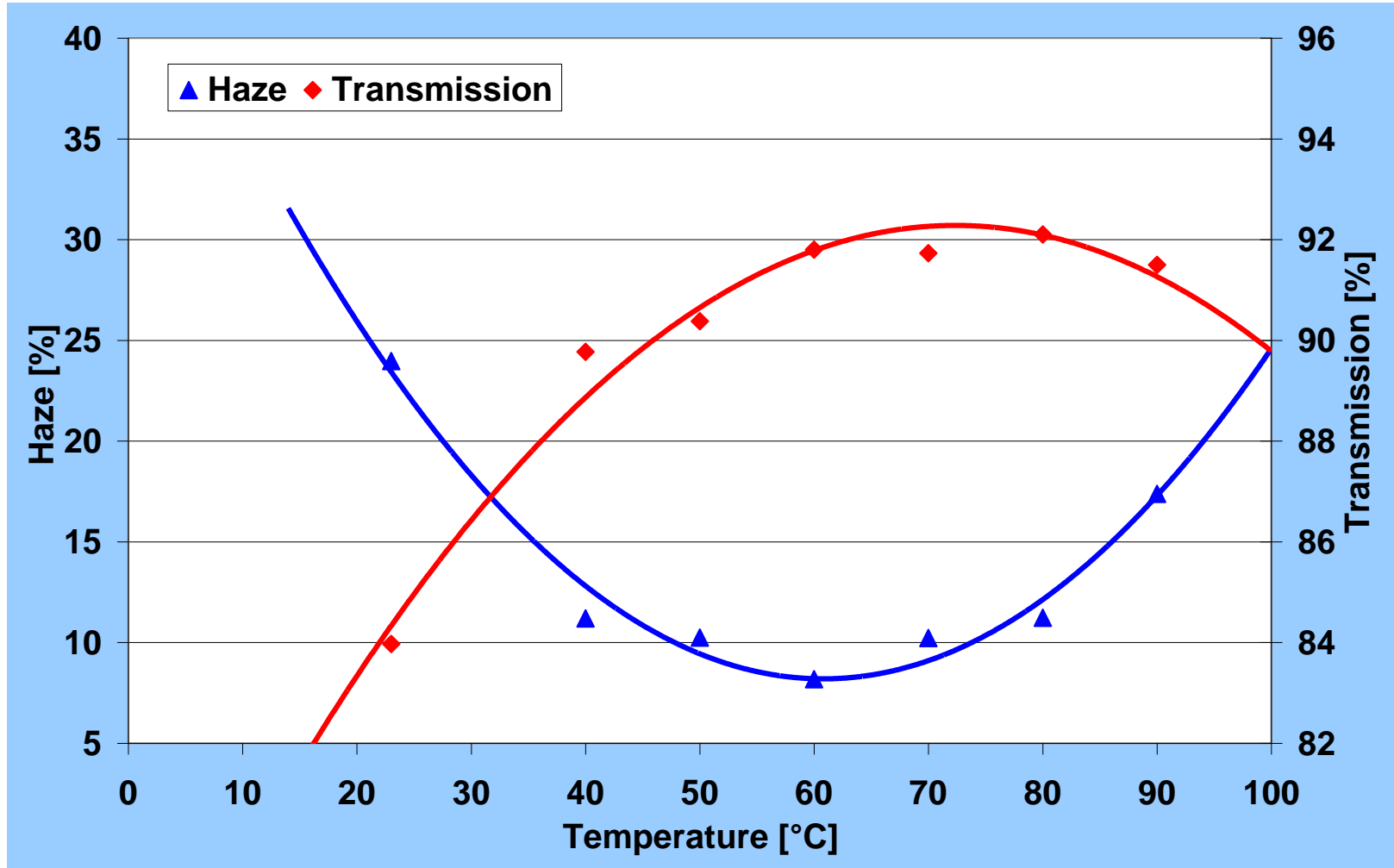
Haze Overview (ASTM D1003)

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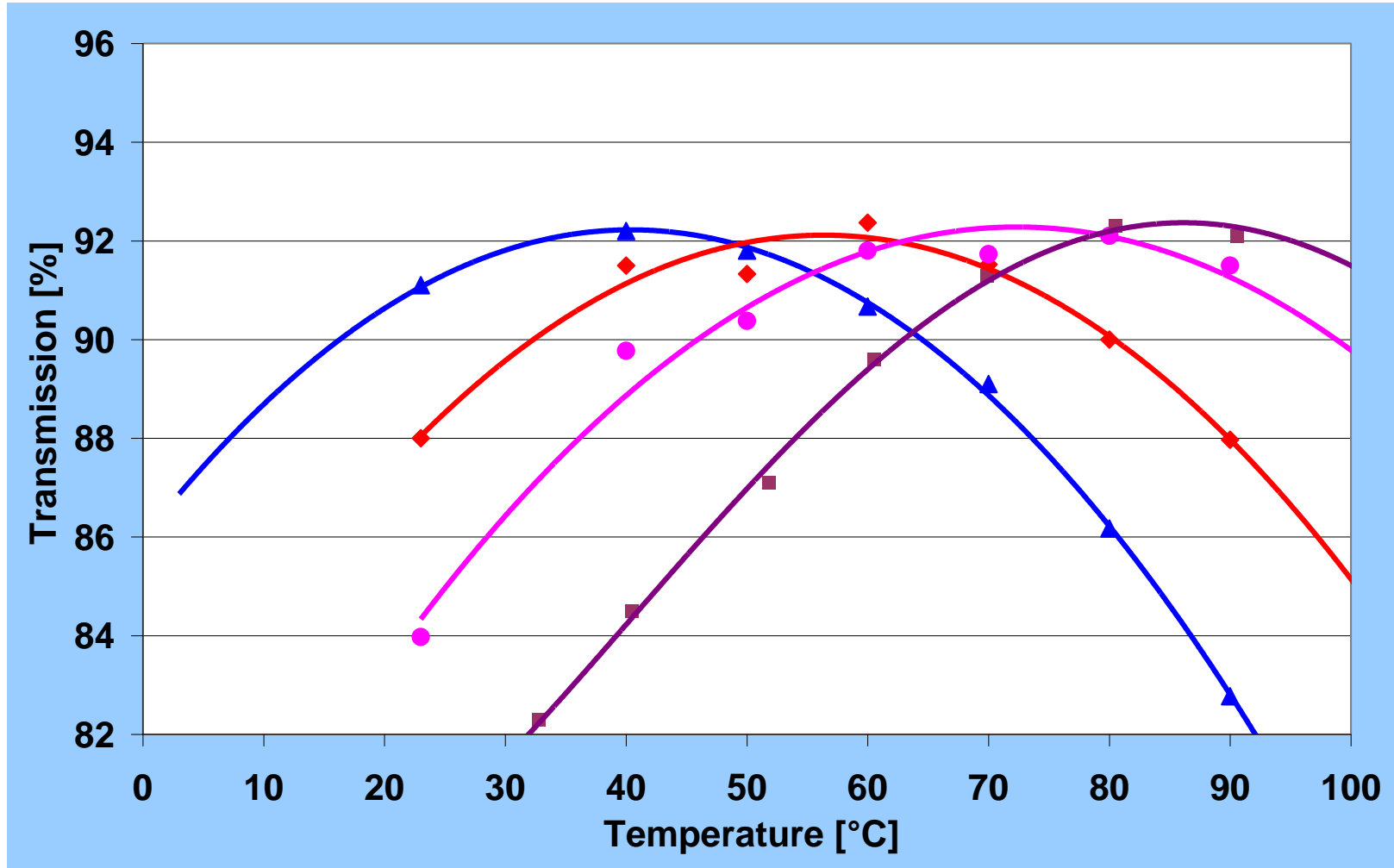
Indicative Mechanical Properties

Not to be used as a specification

Property	Approximate Value
Modulus (MPa)	2000
Yield Strength (MPa)	35
Elongation to Break	12 %
Unnotched Charpy (kJm^{-2})	90
Notched Charpy (kJm^{-2})	10-15
Puncture test (J)	15-25
Vicat B (˚C)	91
MVR (ml/10 min)	10-15

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The imagination is the limit

- **The initial application was for Electrolux dishwasher doors to show the machine in action but hide dirty dishes**
- **Fridge and freezer manufacturers are interested to show whether temperature status at a glance without thermocouples**
- **Designers are investigating the ability to use the effect for novel lighting applications, e.g. harsh to soft transitions**
- **Car manufacturers are interested for example in sunroof use to shield against extreme sunlight**
- **Greenhouses could be built to protect plants from extreme sun**
- **Can be used to simulate fog / poor visibility for example firefighter training exercises**
- **Many more applications in novelty items, etc.**

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Production, pricing and availability

- **Sample material and parts are supplied in partnership with Norner Innovation AS, Norway**
- **Samples provided to interested parties under NDA**
- **Production can be handled in multiple ways:**
  - Smaller volumes from Norner Innovation
  - Larger volumes through Phantom Plastics tolling partners locally
  - Production through OEM compounders via licensing
- **The material is safe with no extractibles, food contact is not in place but could be obtained**
- **Pricing depends on volume and exact material ordered, but is in the region of $ 5-10 / lb**
- **ThermoShift can be developed based on other plastic materials**

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Conclusion

- **We present a new, unique material with a reversible thermo-opaque switching behavior**
- **The material can be made in different grades to provide optimal transparency at temperatures anywhere from -20°C to +85°C**
- **The material shows an excellent balance of mechanical properties e.g. modulus, yield strength and impact resistance**
- **The material is amorphous, allowing use in any standard injection mold made for amorphous materials**
- **The limitations are unsuitability for outdoor use or continuous use at high temperatures**
- **Several Fortune 500 companies are working with Phantom Plastics (exclusivity available on first come, first served basis)**

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