THERMOPLASTIC ELASTOMERS • STRUCTURAL • WEAR

CONDUCTIVE • COLOR • FLAME RETARDANT

A Custom Approach to Color Control – Visible and Beyond

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Outline

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- **RTP Color Division**
- Color Communication
- Light Attenuating
- Laser Welding
- Laser Marking
- Summary

RTP Company Color Division

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- **Color virtually all resins**
  - Engineering resins
  - Styrenic resins
  - Polyolefin resins
- **Color in multiple formats**
  - Masterbatches
  - Precolored resins
  - Cube blends
- **Global color management**
  - Global color synchronization
  - Color standards
  - Fast color matching service

Global Color Consistency

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- **Advanced Color Development**
  - Multiple light sources
  - Regulatory knowledge
    - UL, FDA, USP, RoHS, CONEG, Prop. 65
  - CIE Lab measuring
- **Color Control**
  - Consistent raw materials
  - 8 Color labs
    - USA, France, China, Singapore, Mexico
  - Consistent hardware
  - Consistent software
  - Global database
- **SPEED**
  - Transfers across regions
  - Global color palette

Color Questions

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- Why color the product?
- What should we select as a target or goal?
- How do we know our product is good?
- How do we communicate this information?

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Communicating Color

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- Method of color desired
- Application requirements
- Defined target
- Quality evaluation
- Functional or additive requirements

Coloring Options

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- **Masterbatches**
  - Most widely used form to color commodity resins
  - Concentrated formulation of colorants and/or additives dispersed in a polymer carrier
  - Usage defined by let-down ratio or percentage
- **Precolor**
  - Colorants are added to the polymer and extruded. Ready to use as is
- **Cube blend**
  - Masterbatch is dry blended with polymer

Coloring Options

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- **Masterbatches**
  - Custom
  - Standard Engineering
  - Unicolor
  - Commodity Blacks & Whites
  - Engineering Blacks for Sheet
- **Precolor**
- **Cube blend**
- ***Your Color – Your Way***

Application Requirements

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- Processing Method
- Base Resin
- Regulatory

Target Definition

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- What is the objective?
  - Mating Part
  - Stand alone part
  - Color coding
- Application setting
  - Surface, texture, gloss, and surrounding will influence the overall appearance

Color Evaluation & Control

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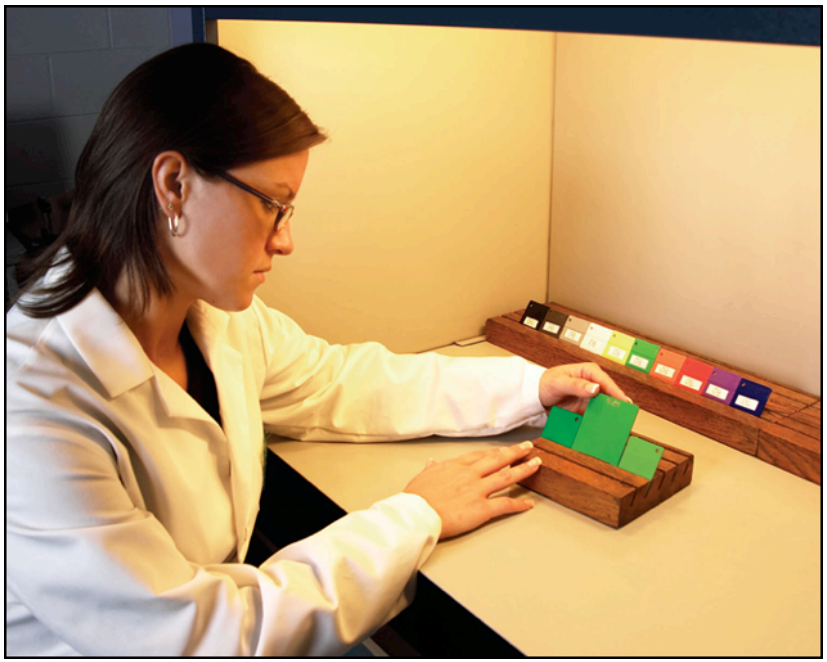
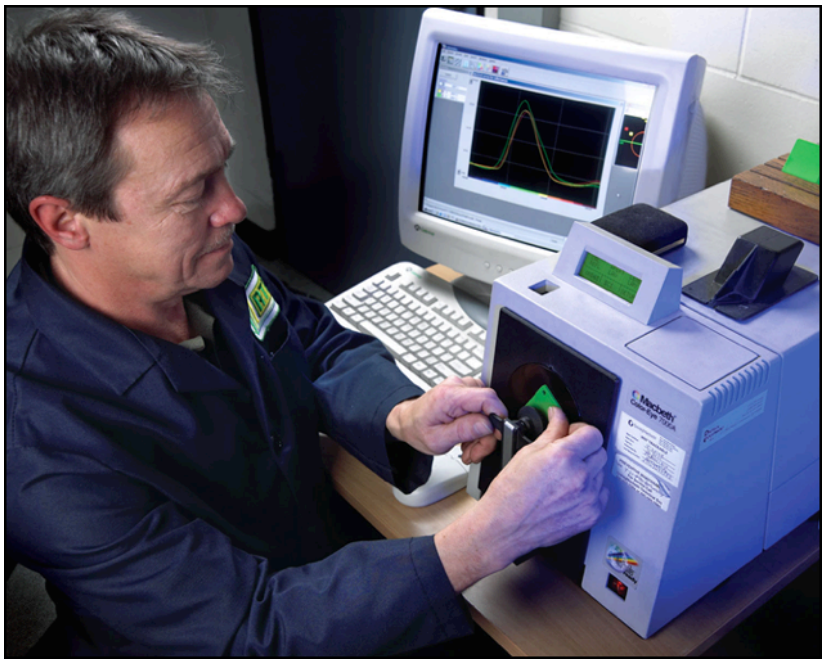




Visual Color Evaluation

- Confirmed color vision
- Color standards for reference
- Controlled light
- Agreed upon color space

Instrumental Color Evaluation

- Calibrated machine
- Color standards for reference
- Controlled temperature
- Agreed upon color space

Measuring Equipment

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Color-Eye® 7000A

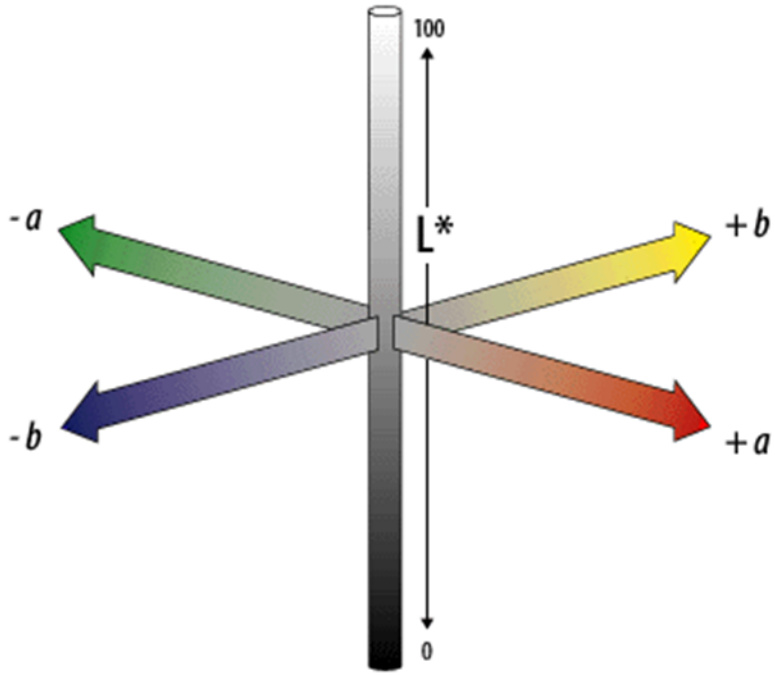
Spectroradiometer

Color Specification & Tolerances

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Numeric Color Modeling

- **CIE L*a*b* is most popular**
- **Numeric model provides**
  - 3 dimensional color space
  - Quantify colors numerically
  - Can be used for specification, identification, comparison
- **Identified by L* a* b* values**
  - L* = lightness to darkness
  - a* = redness to greenness
  - b* = yellowness to blueness
  - ΔE = total color difference



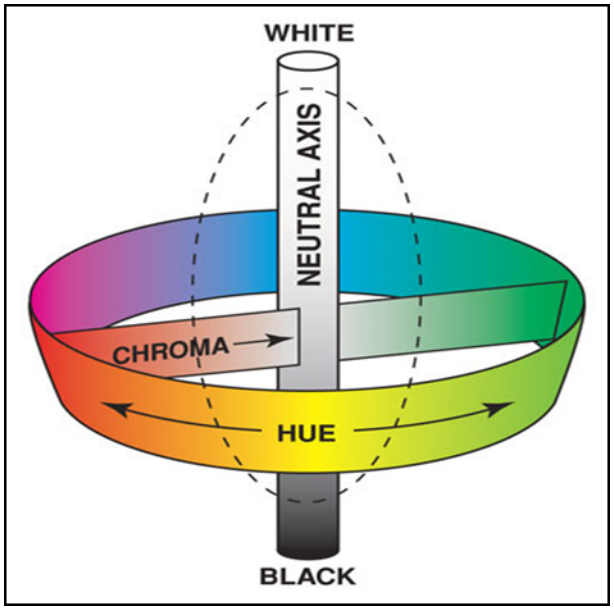
$$\Delta E^* = \sqrt{(L_2^* - L_1^*)^2 + (a_2^* - a_1^*)^2 + (b_2^* - b_1^*)^2}$$

Color Specification & Tolerances

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Numeric Color Modeling

- **CMC LCH**
- **Numeric model provides**
  - 3 dimensional color space
  - Quantify colors numerically
  - Can be used for specification, identification, comparison
- **Identified by L*C*h° values**
  - L* = lightness to darkness
  - C* = chroma
  - h° = hue
  - ΔE_{CMC} = total color difference



$$\Delta E^*_{CMC} = \sqrt{\left(\frac{L^*_2 - L^*_1}{l\,S_L}\right)^2 + \left(\frac{C^*_2 - C^*_1}{cS_C}\right)^2 + \left(\frac{\Delta H^*_{ab}}{S_H}\right)^2}$$

CMC LCH Color Model

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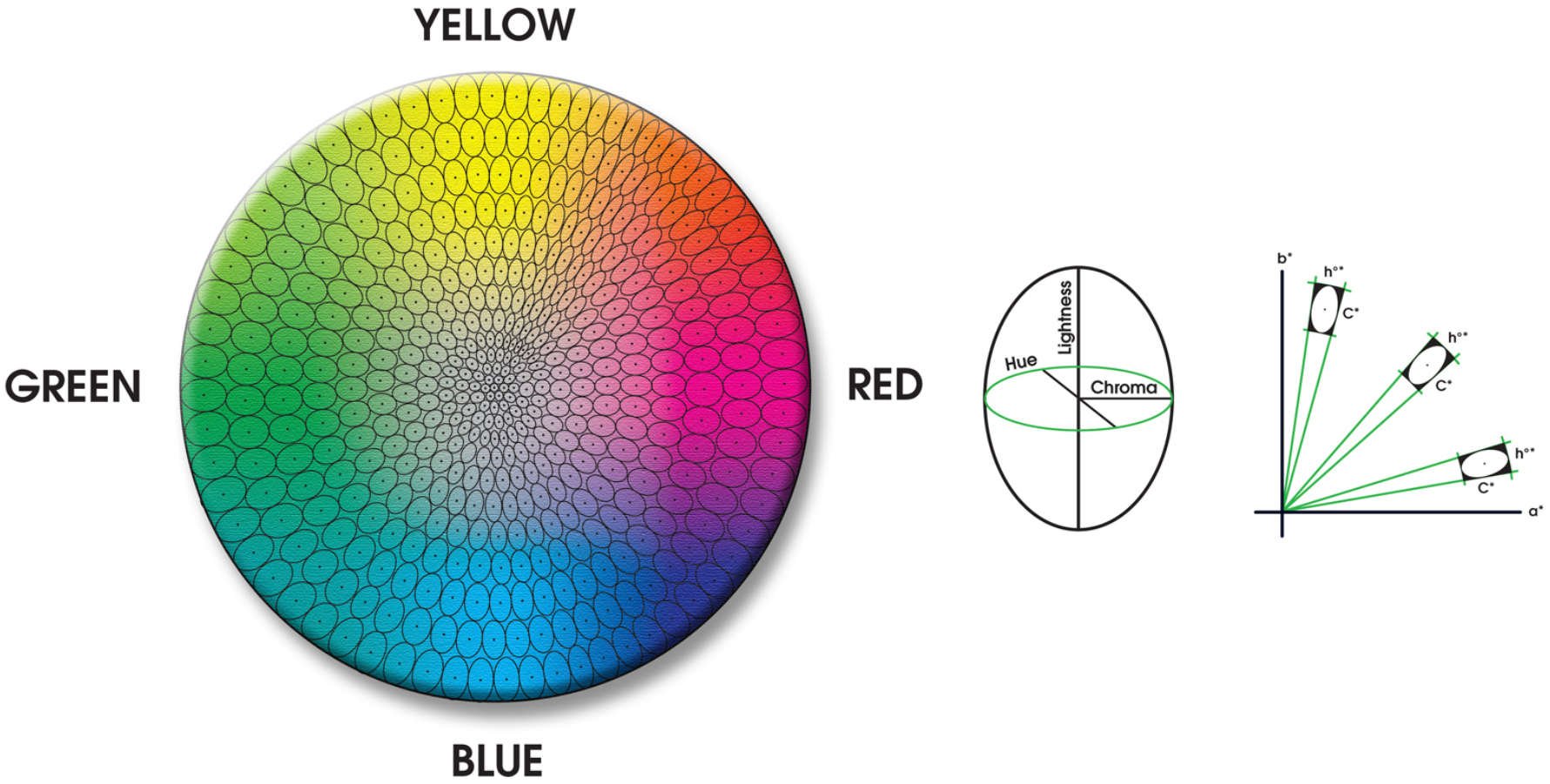

CIE Lab ΔE

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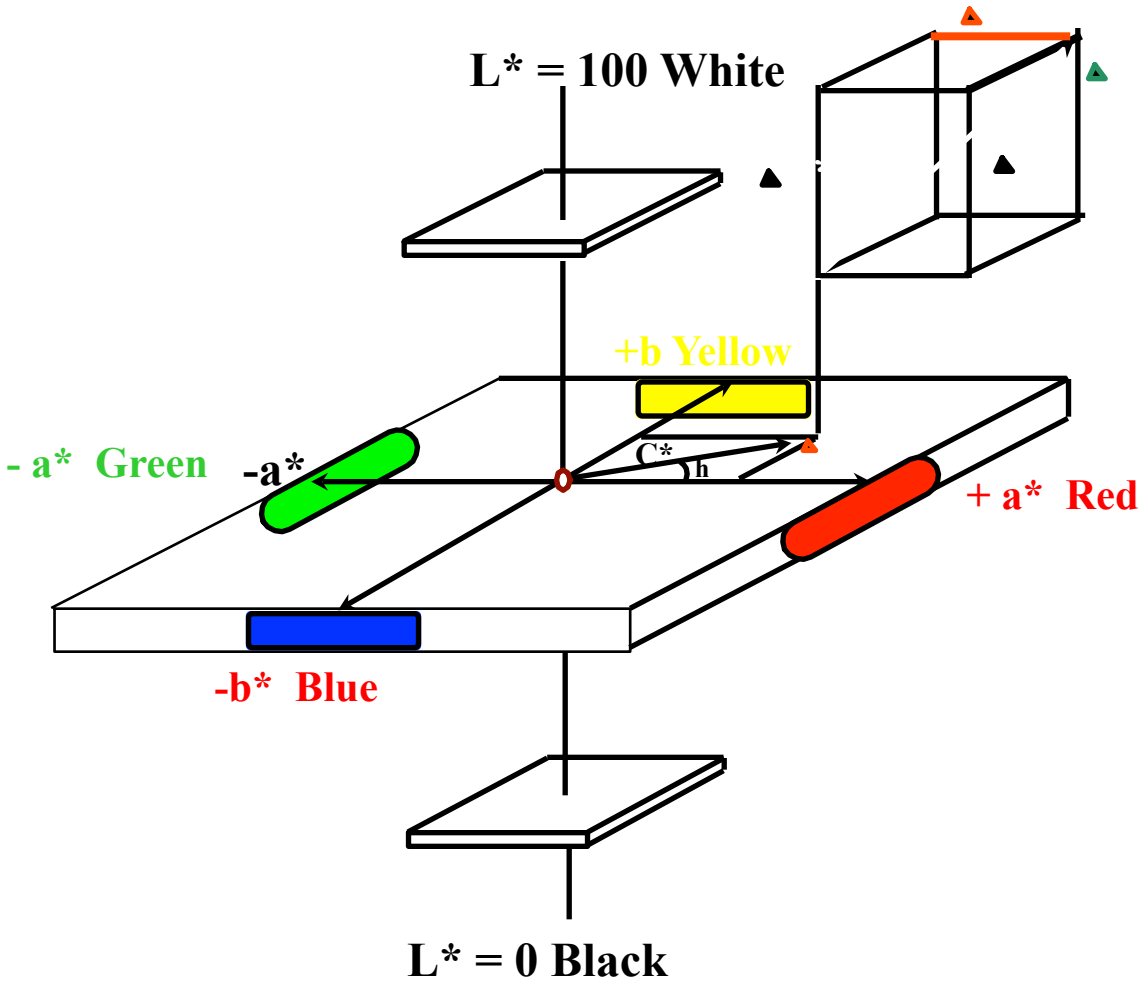
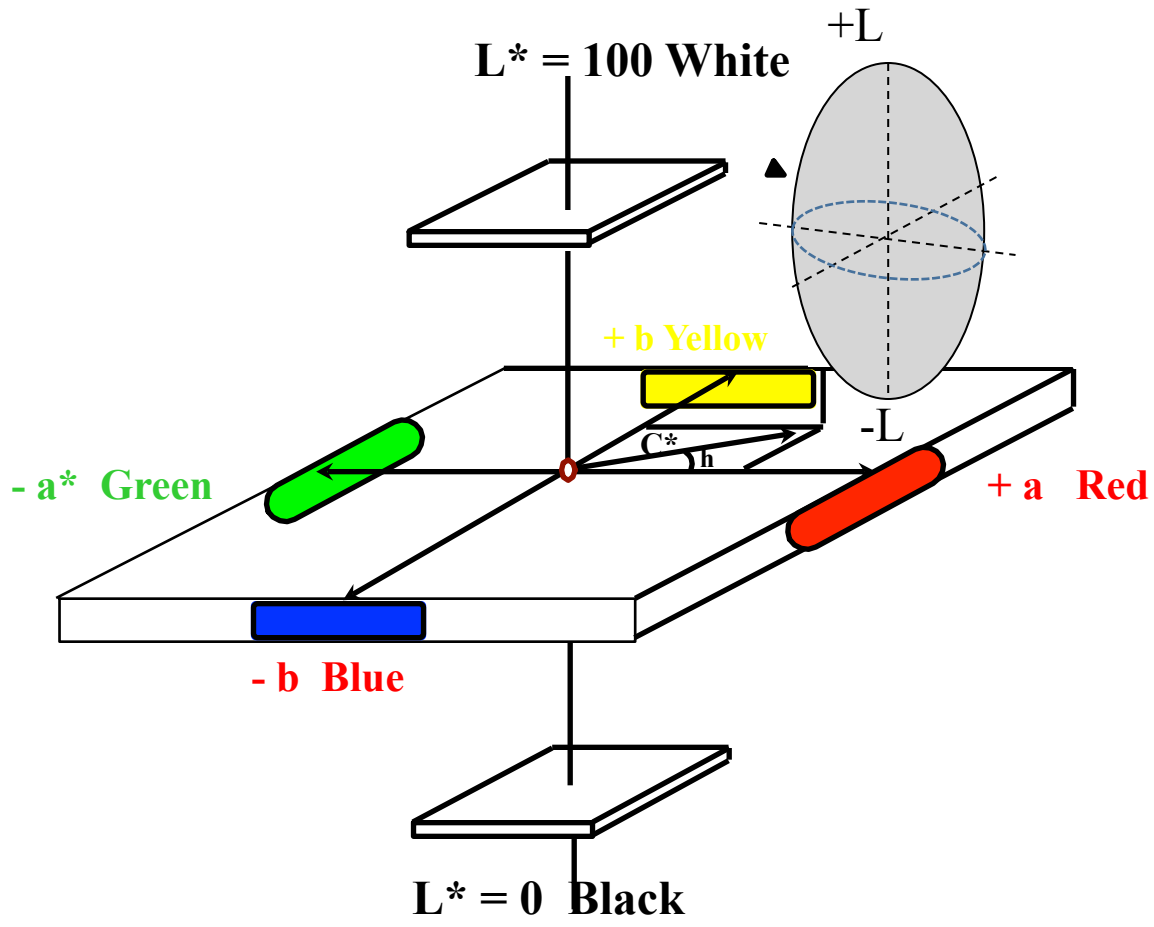
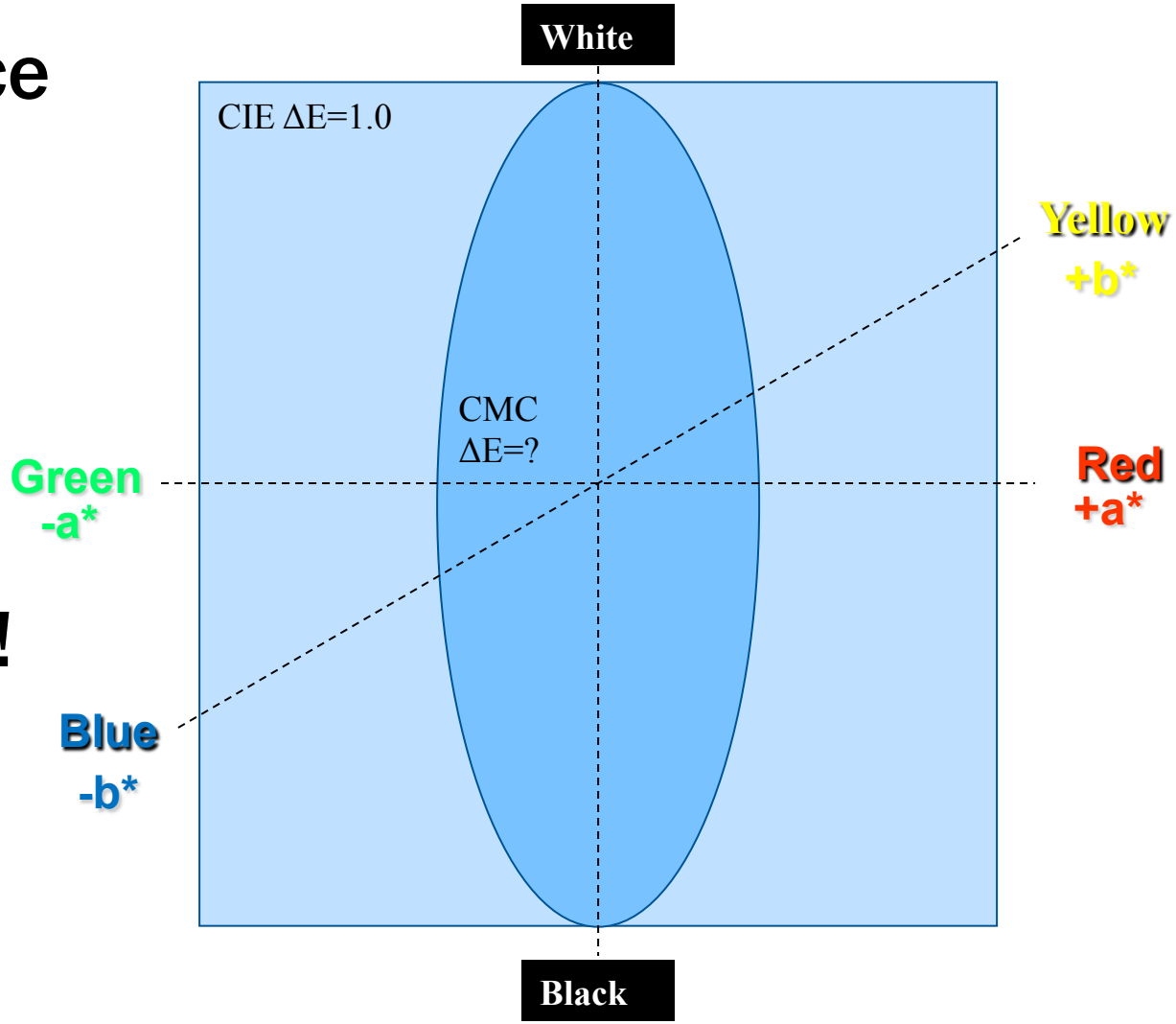


L* = 43.31
a* = 47.63
b* = 14.12



L* = 43.31
a* = 47.63
b* = 14.12

CIE color space numerically acceptable, yet visually unacceptable!



CMC ΔE

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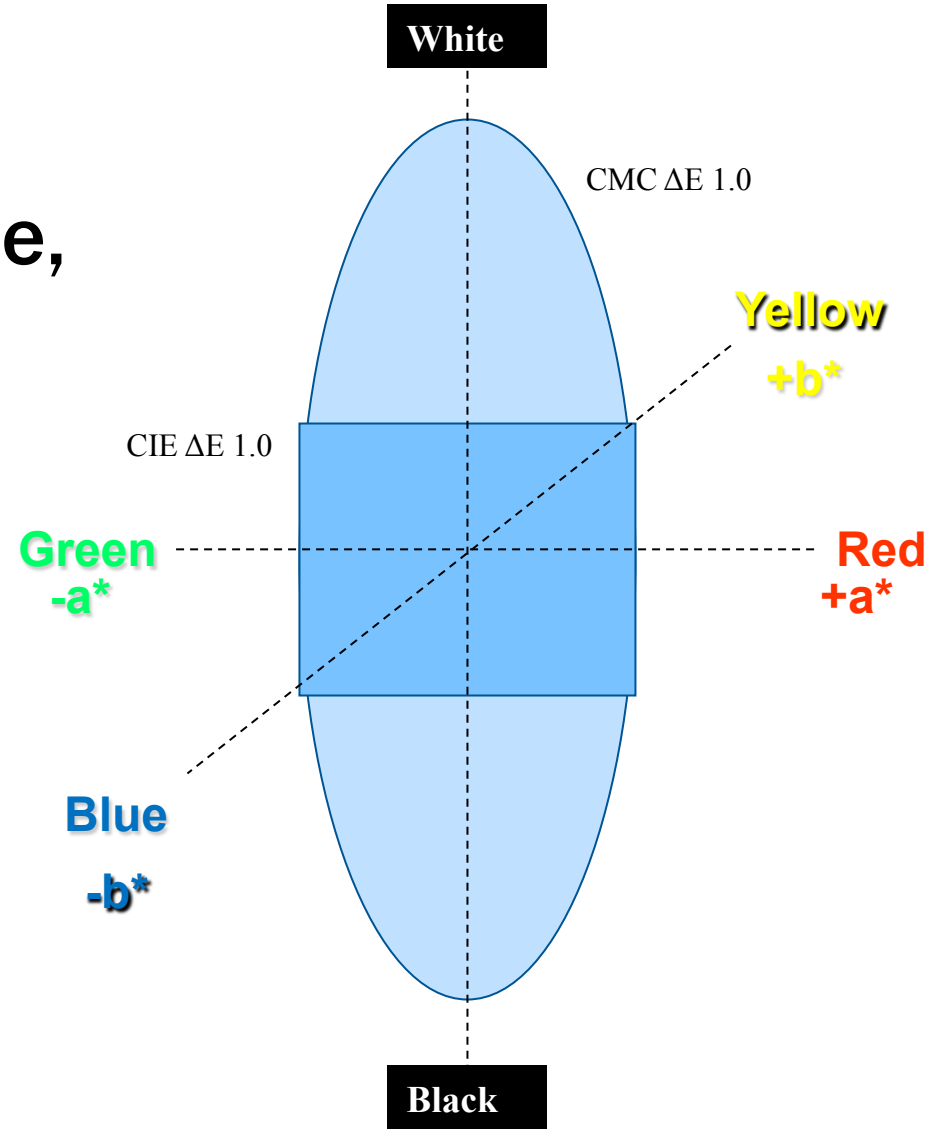
CIE Color Space is numerically acceptable, yet visual acceptable space in CMC ellipsoid is numerically out!



Metamerism

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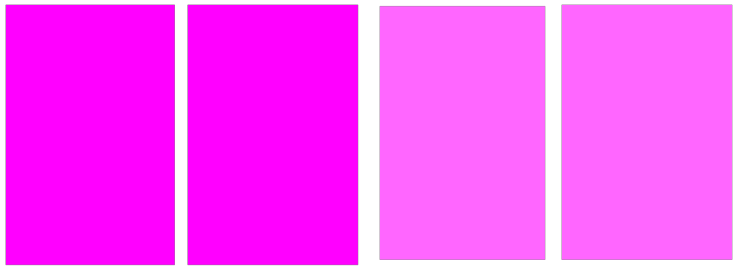
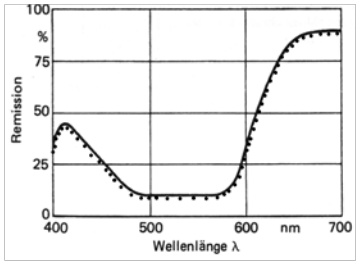
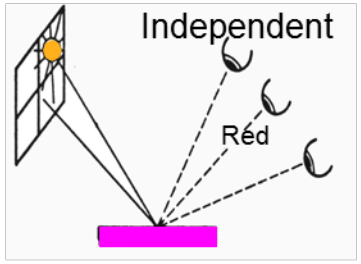
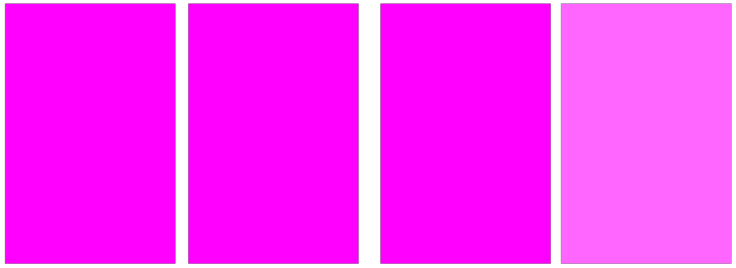
Light source	Reflectance	Viewing angle

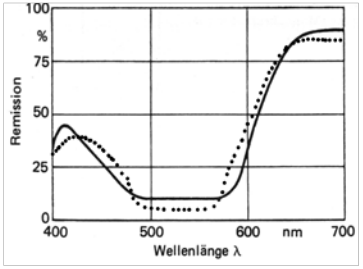


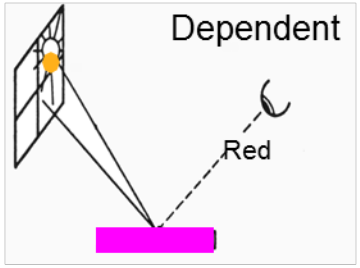




Metamerism - free







Metamerism

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- **Light Attenuating**
- Laser Welding
- Laser Marking
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Light Attenuating

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- Block specific wavelengths
- Transmit at specific wavelengths
- Twilight sensors, remote controls

- Active 700 – 2500 nm range
- Transparent or opaque at specific wavelengths
- Combination of light controlling attributes
- Fiber optics
- Transmitters/receivers

NIR Transmitting

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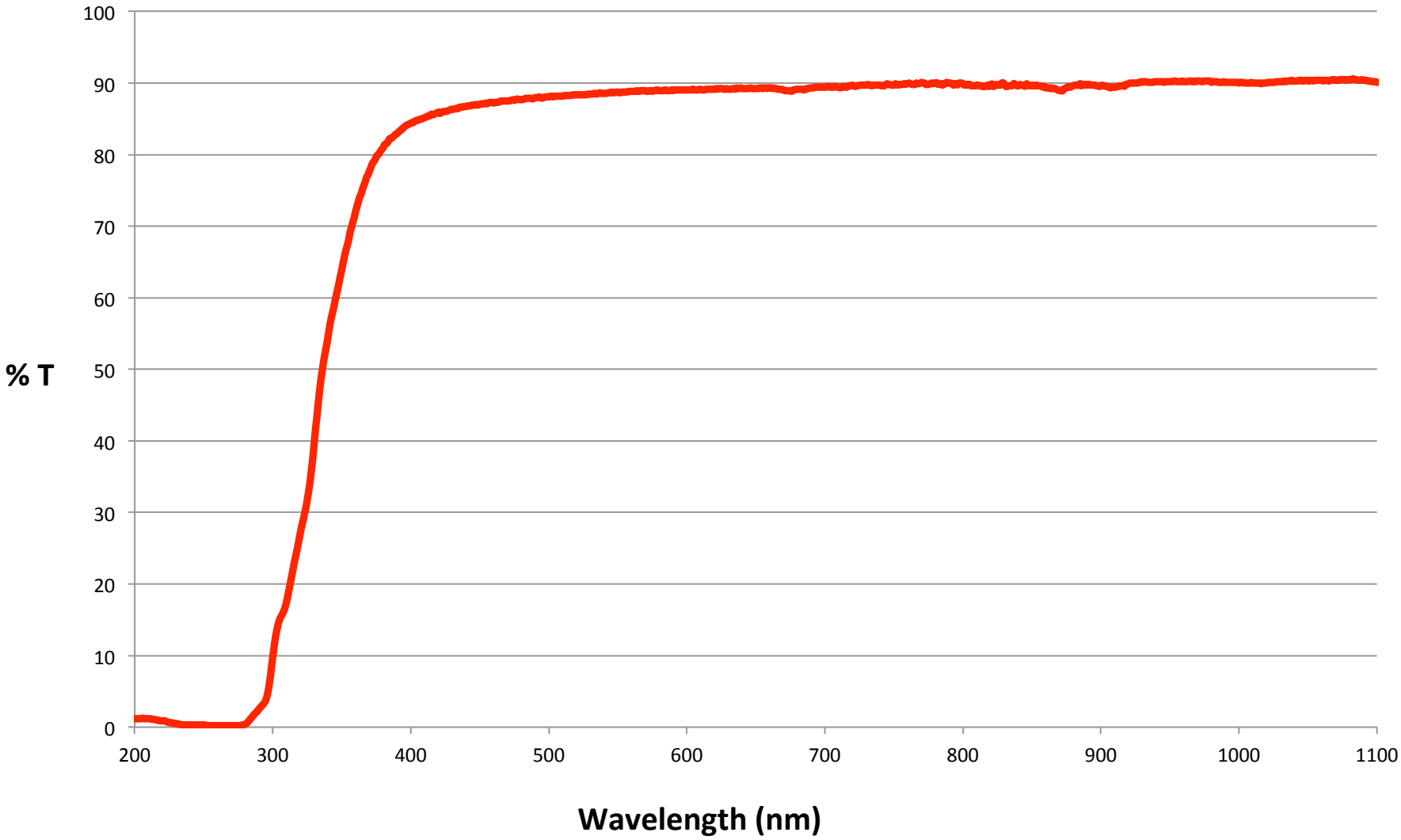

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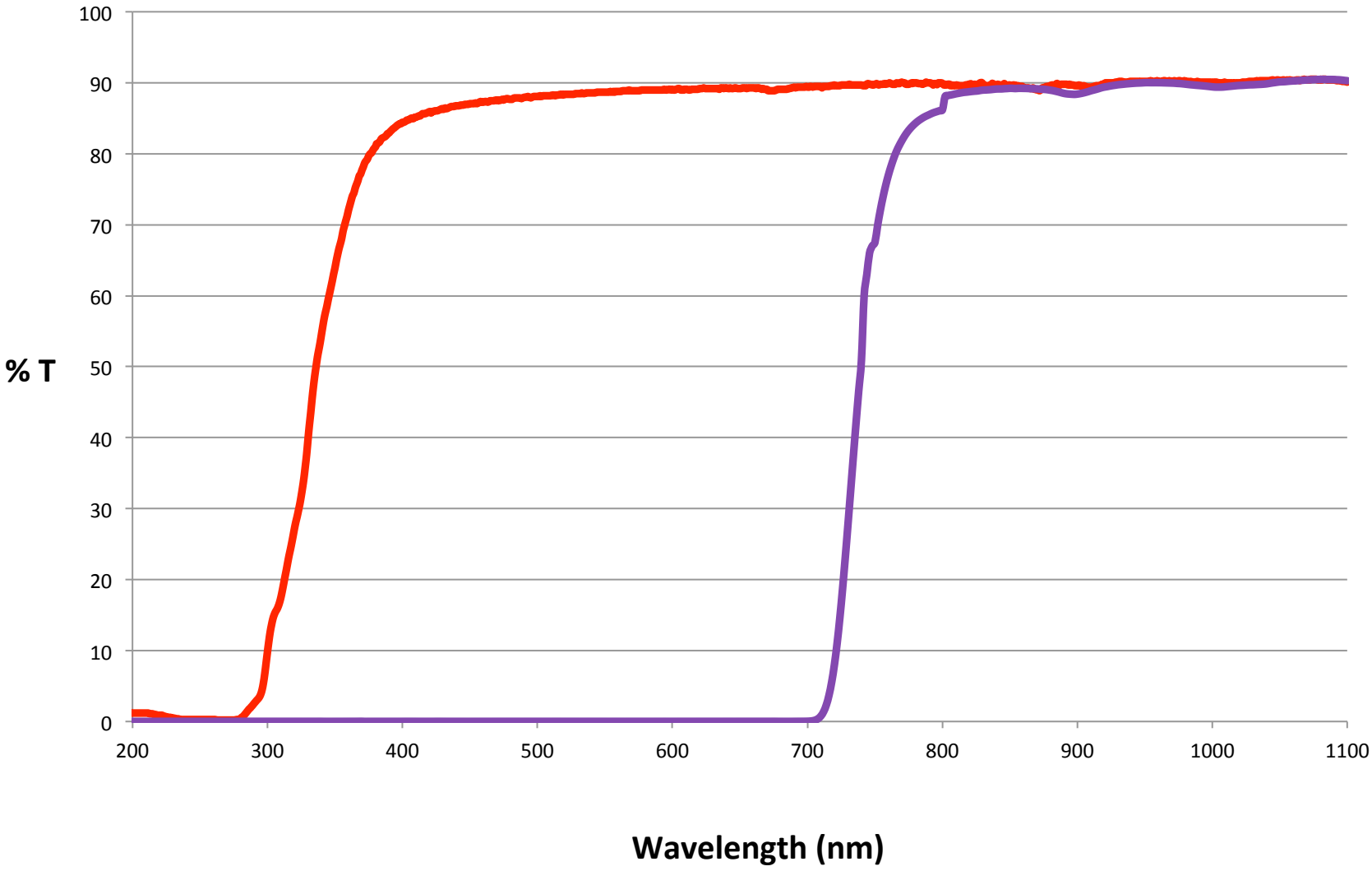

NIR Transmitting

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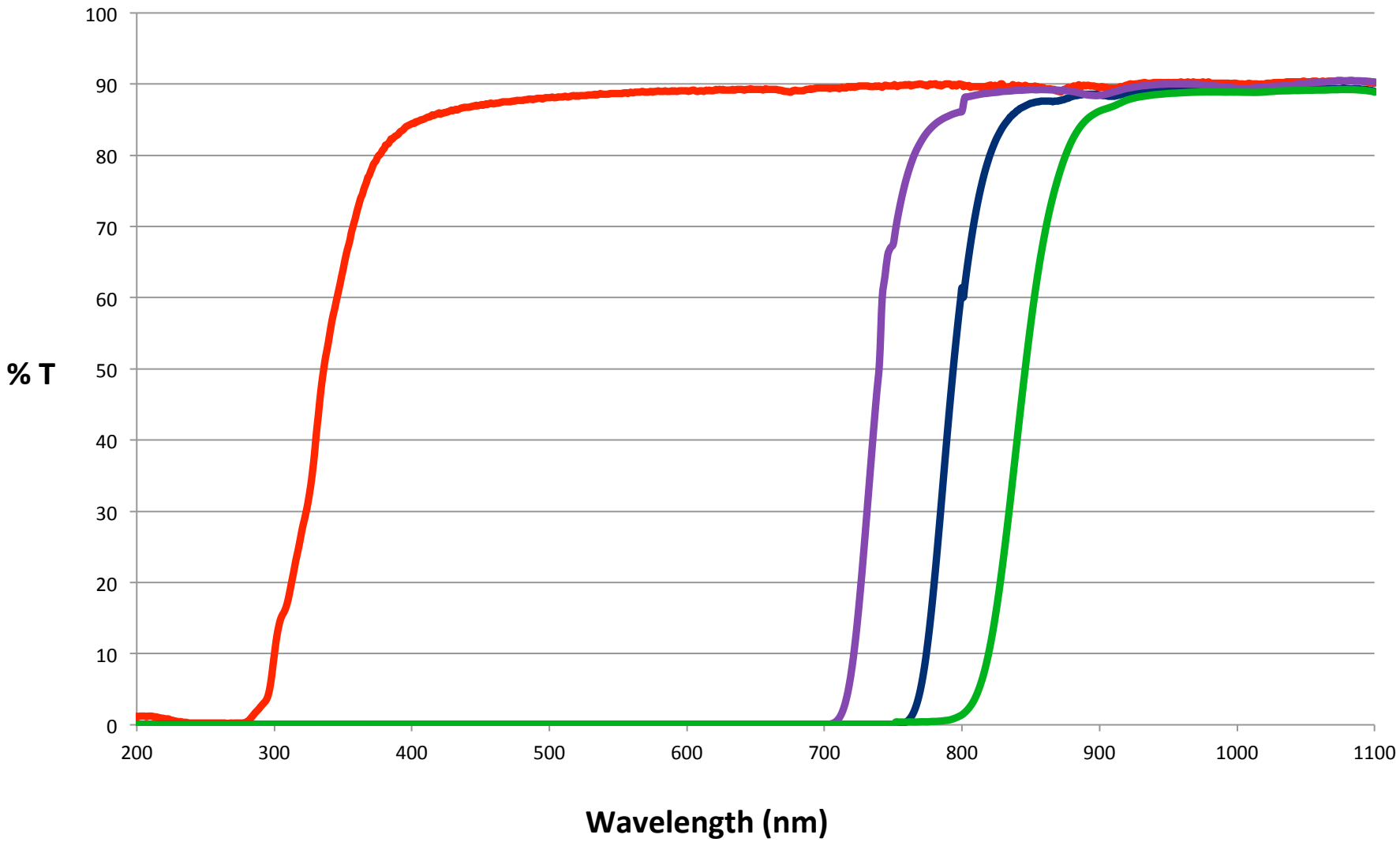

NIR Absorbing

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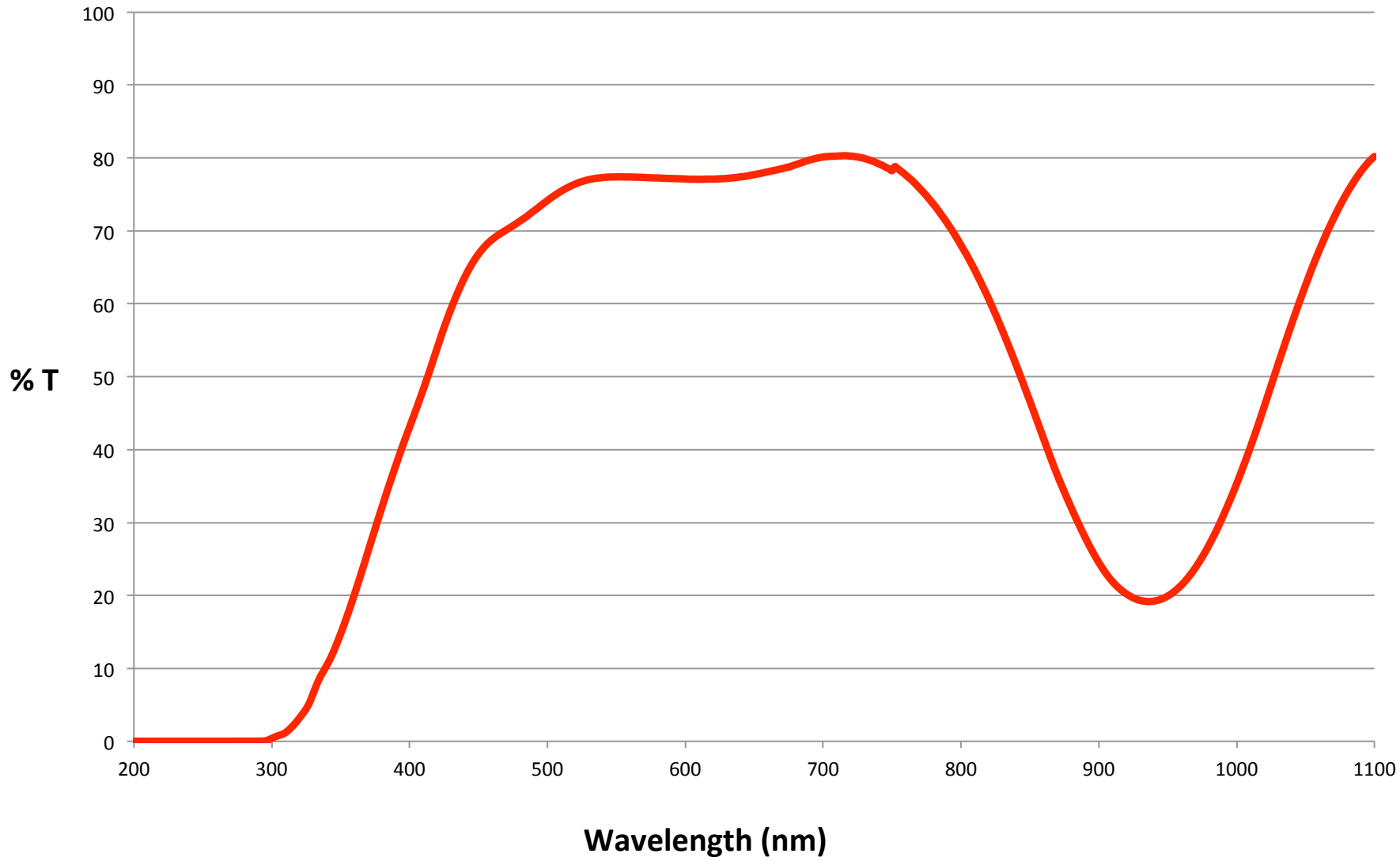

Visible Absorbing

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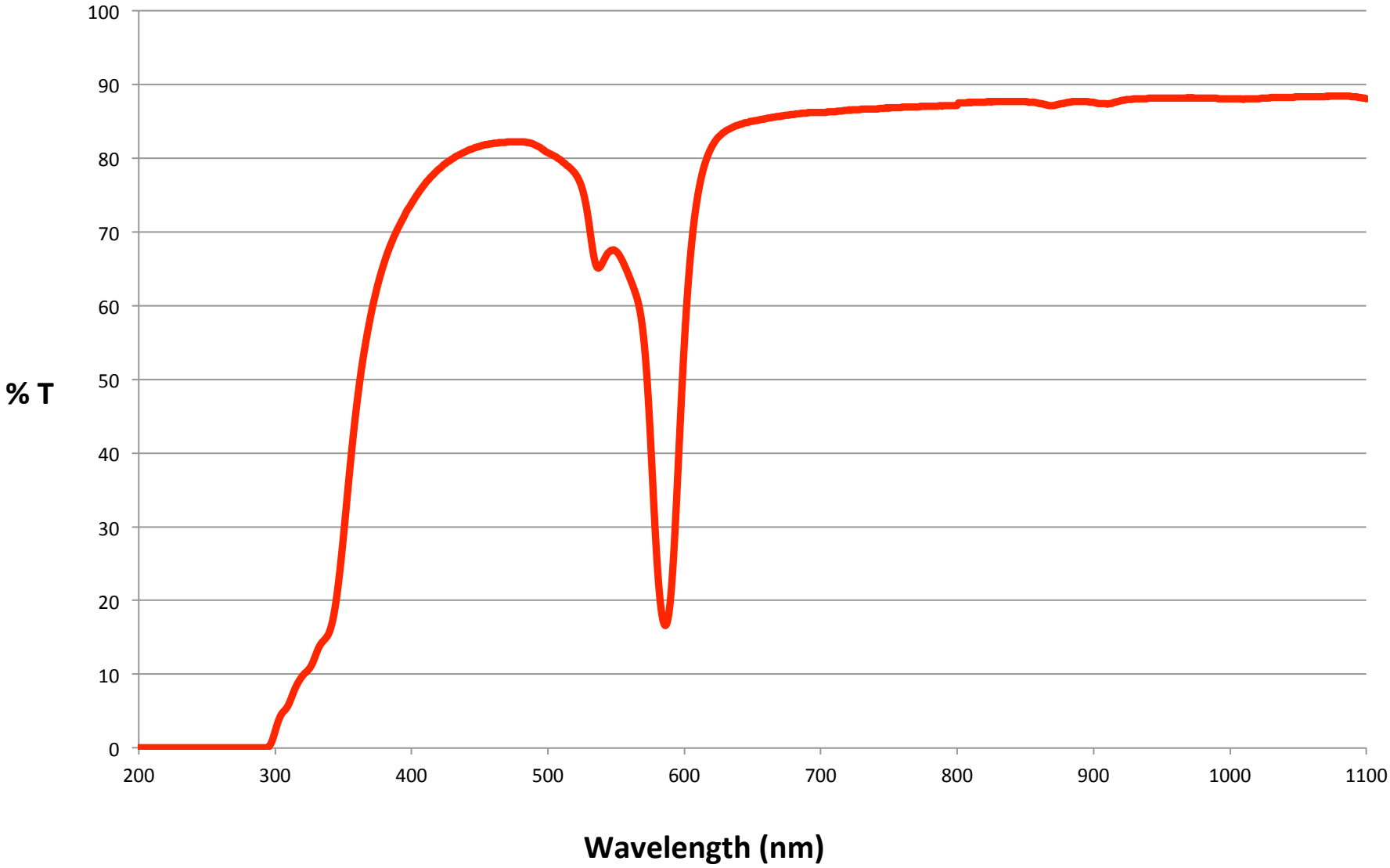

NIR attenuation application

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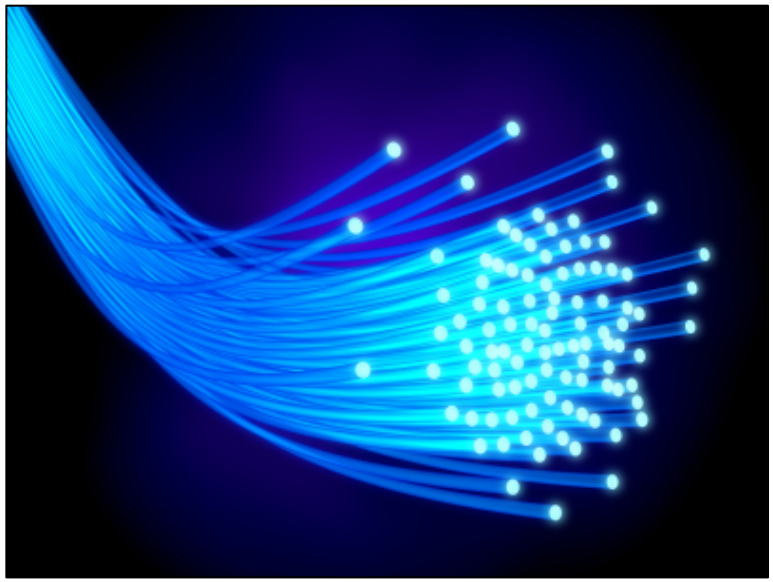
Market: Communications

Application: Fiber optic connector

Problem: Precise attenuation requirements

Solution: RTP Company pre-color NIR semi-trans black

Benefit: Precise attention at various target transmissions



Outline

- RTP Color Division
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- **Laser Welding**
- Laser Marking
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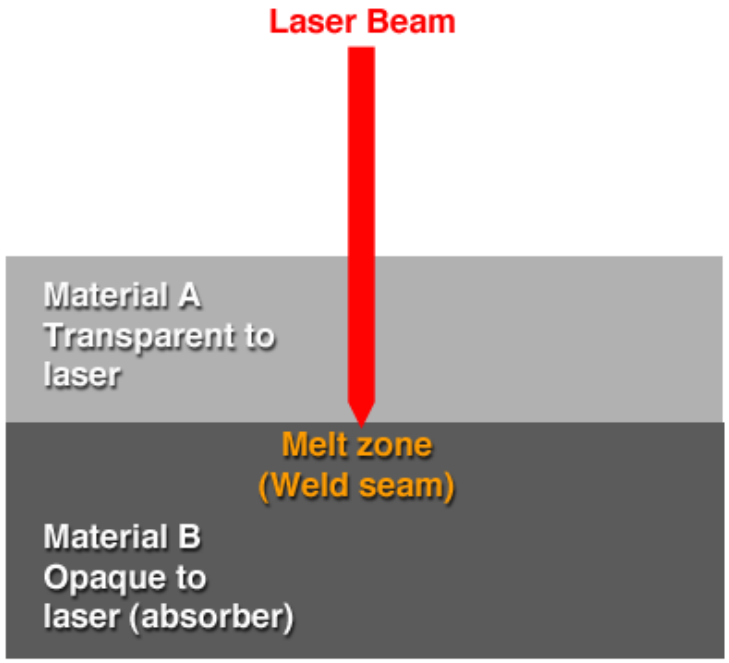
Laser Welding

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

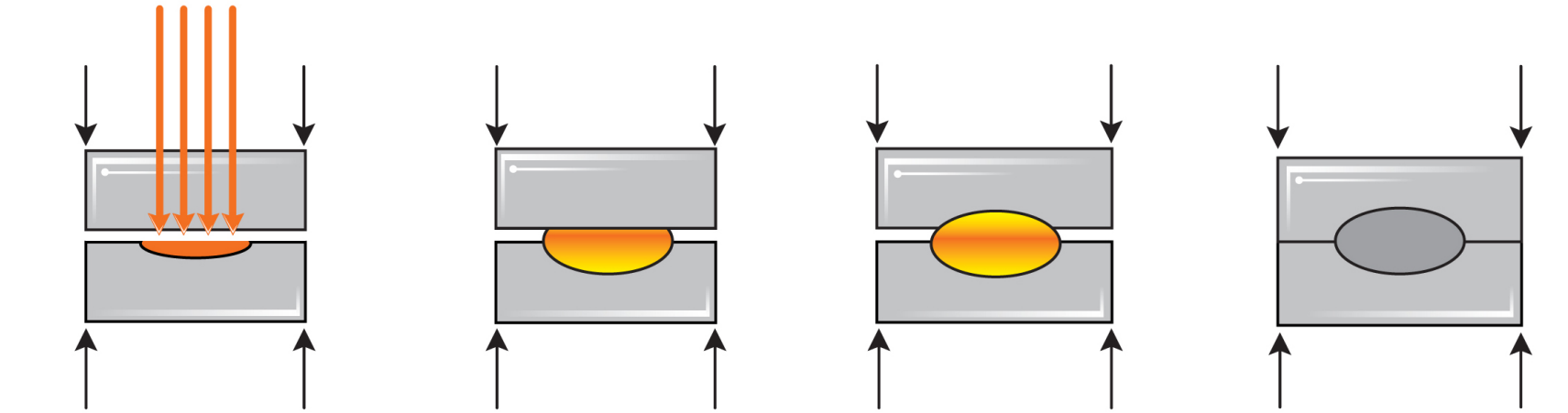
- **Method for joining thermoplastic parts by using the thermal power of laser to bond materials**
  - Useful when the parts being joined are delicate
  - High speed makes it valuable for bonding automotive plastic housings/sensors
  - Flexibility of the laser makes it ideal for complex shapes



Laser Welding of Thermoplastics

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- Transmissive medium
- Absorbing medium



Welding Methods

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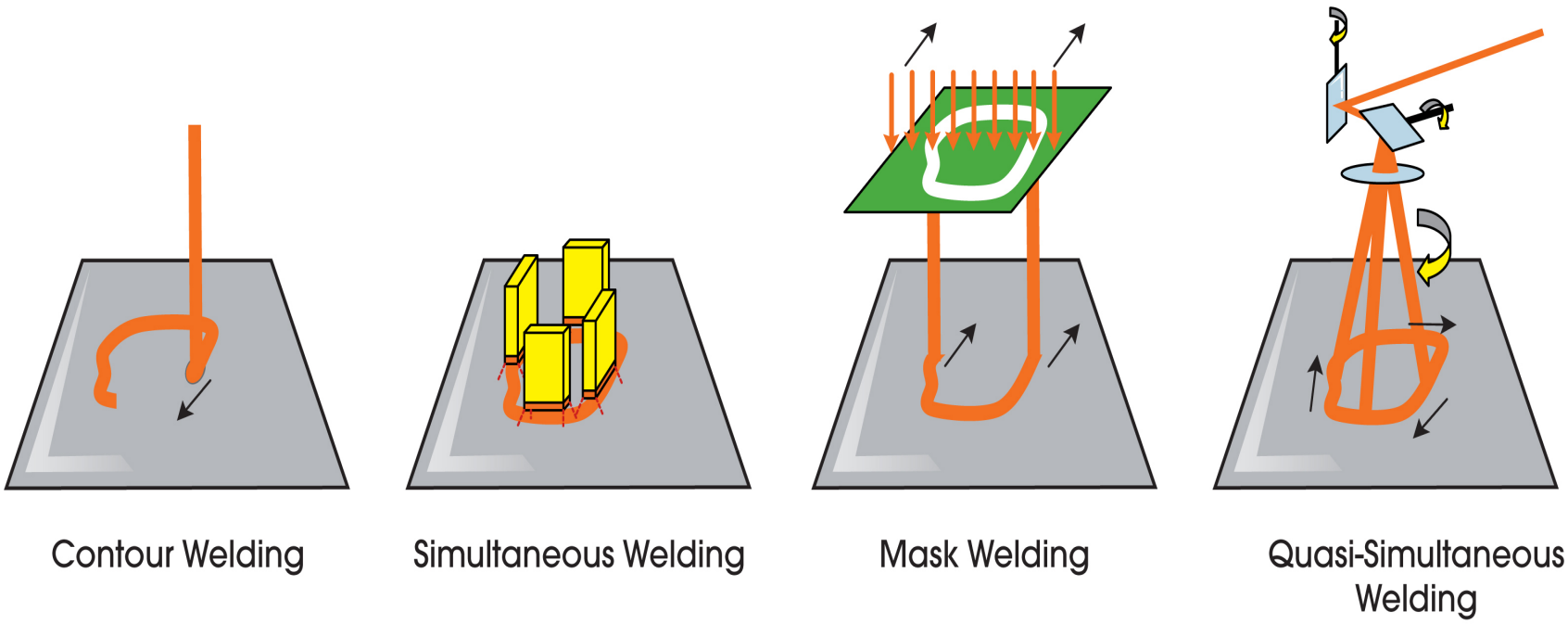
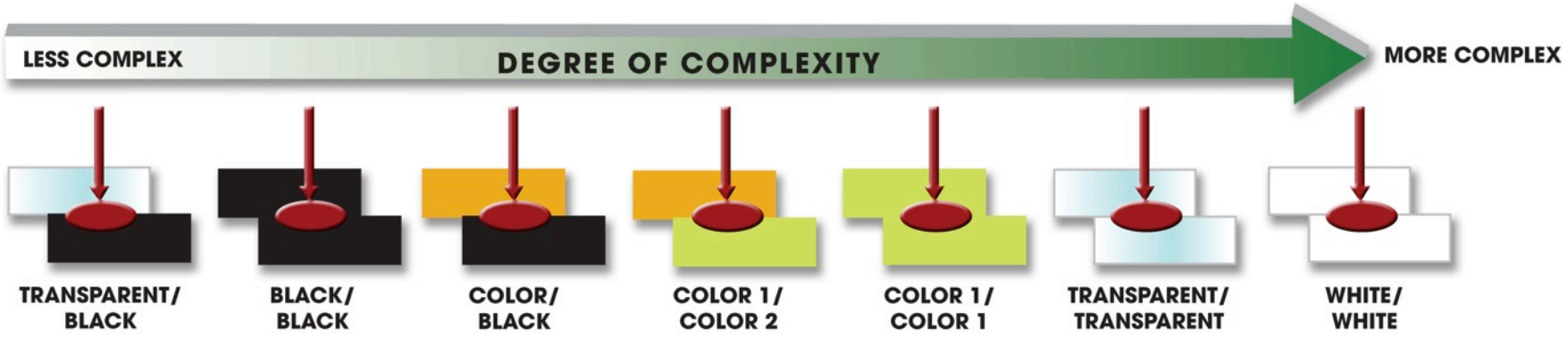
- Advantages
- Disadvantages



Laser Welding of Thermoplastics

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- The below chart indicates the degree of complexity for laser welding of various colors combinations
- RTP Company has experience with pigment/filler combinations, and loading levels, to support successful welding using both Diode and Nd:YAG lasers



Laser Welding of Thermoplastics

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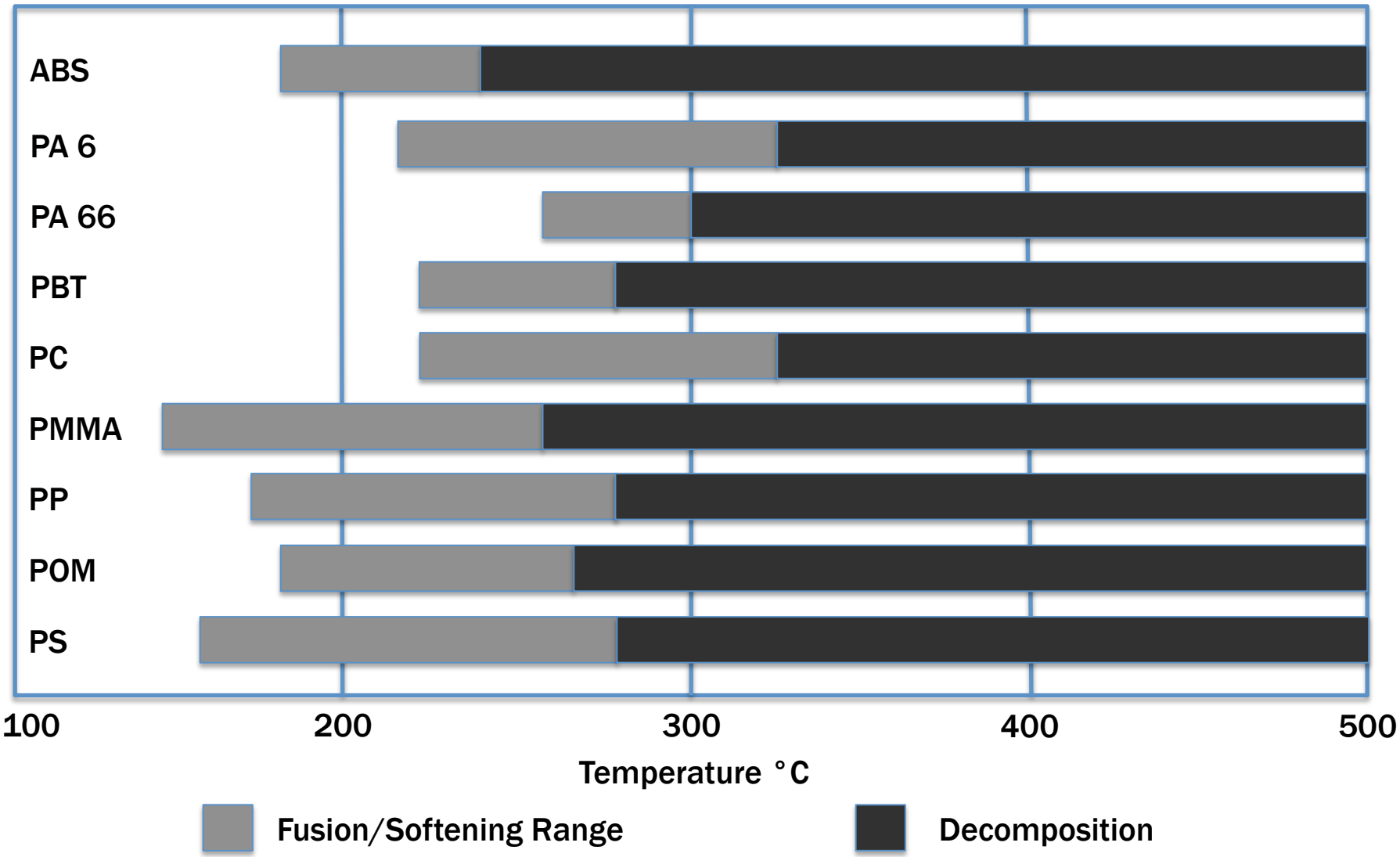
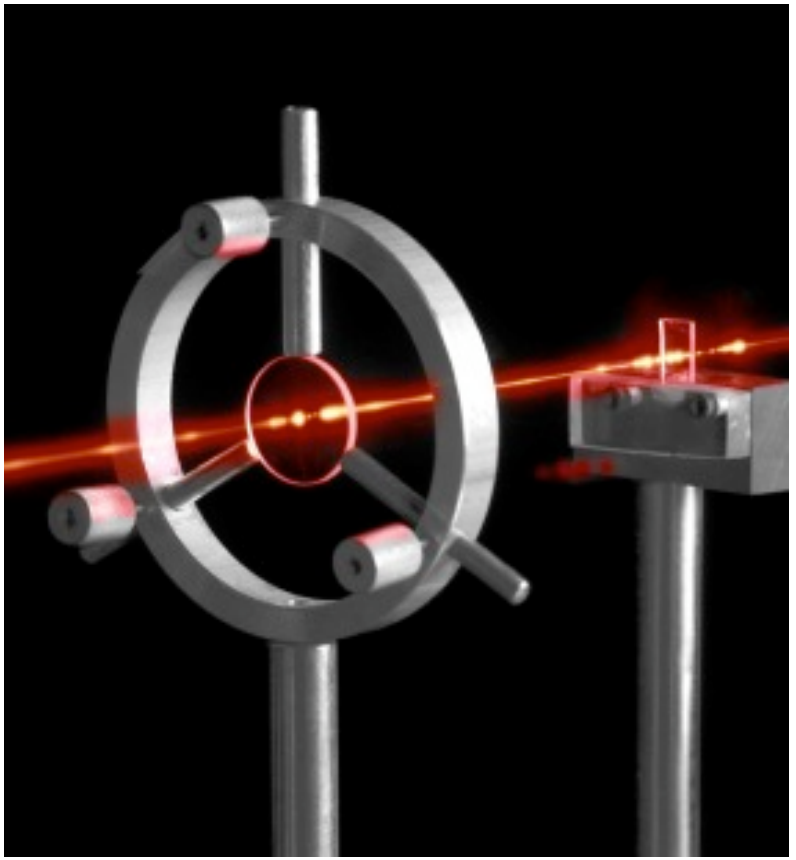


Laser Welding of Thermoplastics

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- **Advantages**
  - No contact with plastic part
  - Relatively high speed
  - Can weld complex parts
  - No flash is produced
  - High-precision joints can be produced
  - Gas-tight, hermetic seals are possible
  - Thermal distortion is minimal
  - Resins of different compositions can be joined
  - No consumables (adhesives, fasteners, etc.)



Laser welding application

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Market: Automotive

Application: Sensor housing

Problem: Cost efficient dependable bond in harsh environment

Solution: RTP Company structural Nylon 6:6 laser welding color

Benefit: Fast and consistent welding

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Laser Marking

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- **Laser-marking can be achieved in conjunction with color and other additives**
- **Various commercial additives exist for FDA applications**
- **Unique colors achievable**
- **Dark or Light marks**
  - Charring
  - Foaming

One Light – Two Marks

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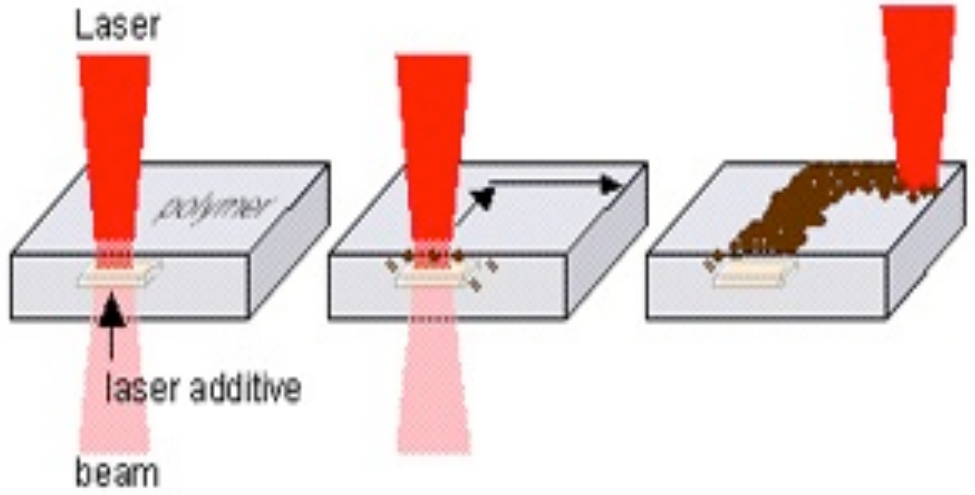
- Charring produces dark mark
- Foaming produces light mark



- Keypads, toys, medical, automotive
- FDA
- Combined with other technologies
- Unique colors achievable
- Dark or light marks

Laser Marking

- **Different lasers can be used, but Nd:YAG (Neodymium doped Yttrium Aluminum Garnet) is the best compromise of…**
  - Speed
  - Flexibility
  - Marking quality
- **For most thermoplastic applications**

- **Typical settings**
  - Output power 20-25 amps
  - Pulse rate 5000-6000 Hz
  - Beam velocity 300-400 mm/s

Marking Considerations

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- Difficult to achieve “good” marking with certain color combinations/contrasts
- Same material in different colors can and often do mark differently
- All components have an effect on the marking
- It is often possible to improve the mark with proper additive/color selections

Laser marking application

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Market: Agriculture

Application: Livestock identification tags

Problem: Demanding environmental exposures

Solution: RTP Company's color plus laser marking masterbatch

Benefit: Resilient high contrast marking

- **With Traditional color**
  - Livestock tags
- **With various functional additives**
  - UV, lubricants, wear, etc.
- **With structural compounds**
  - Automotive sensors
- **With medical requirements…**

Medical Colors

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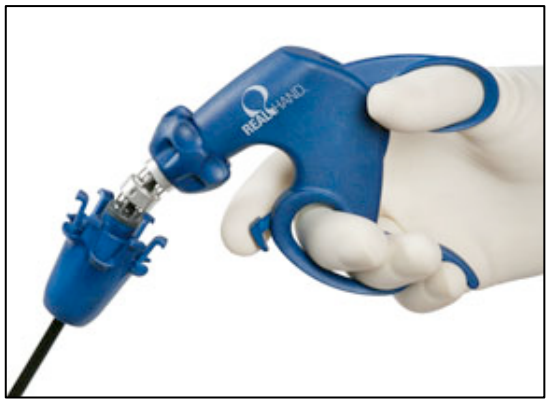
Bio-Tested Colors

- ISO 10993-1 Tested
  - Part 5, in vitro ***cytotoxicity***
  - Part 10, ***irritation*** and delayed type hypersensitivity
  - Part 11, ***systemic toxicity***
- 18 Standard Colors
- Custom color or masterbatch
- Statement of Biocompatibility

Medical Color Applications

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Trauma Shears
Glow-in-the-Dark



Surgical Tool
Branded Colors

Respiratory Humidifier
Transparent PC

Dental Chair Housing
PC/ABS precolor

Special Effects

- Laser marking
- Glow in the dark
- Marble, metallic, pearlescent
- Translucent
- FDA approved colors

Color

- Standard color palette
- PP clarifiers
- Custom coloring

Outline

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Summary

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- Dedicated supplier
- Precolor, Masterbatch, Cube Blend
- Ultraviolet – visible – near infrared
- Wavelength selective and tolerance minded
- Welding and marking
- Like the “head scratchers” & solving problems
- Competitive solutions

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Questions?

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