Electrochromic Technology Developments for Automotive Windows

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The miracles of science™

Program Objective

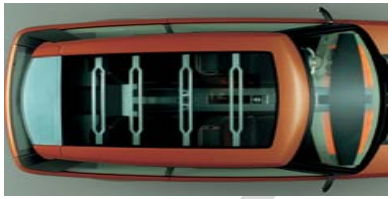
Develop a dynamic electrochromic (EC) glazing technology that reduces cost and expands the functionality of automotive sunroofs and mirrors.

Applications: automotive mirrors, sunroofs
Expansion to: architectural windows, skylights, interior partitions, sunshades

Sun Roof Market Trends

- Greater glass surface area being designed into automobiles including larger sunroofs
- Customers prefer a more open feeling in the auto, and the perception of more interior space, but need protection from sun glare for comfort
- Push toward more fully integrated comfort and convenience functions
- As glass roofs become larger, mechanical blinds become more difficult to implement
- Automotive industry is open to consider EC glazing for sunroof application because of success in rearview mirrors.

"light on demand"



Panoramic Roofs

Sliding Panorama Roofs

Current Market : 8-10 MM units/yr

- 30% growth in large sunroofs
- 15% growth in all sunroofs
- 15 to 20% increase in average size in last 4 years
- Repeat purchase rate high - 78%
- High penetration rate in all segments (luxury, intermediate, compact SUV)

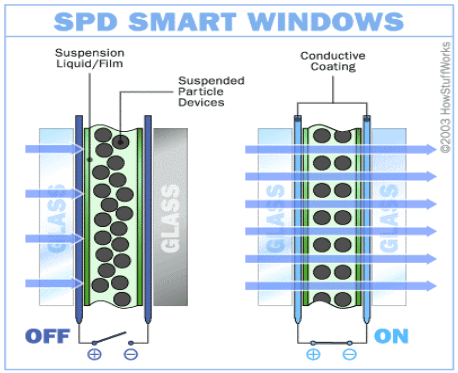
Value

Past | Today | Today and future

Growing need to control light

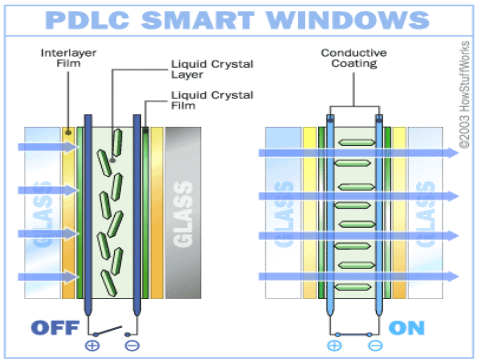
Competitive Technologies

Suspended Particle Devices (SPD)



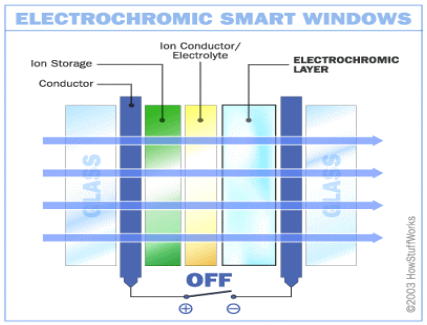
Solid particles in a liquid drop dispersed in a matrix. Difficult to make and apply layer

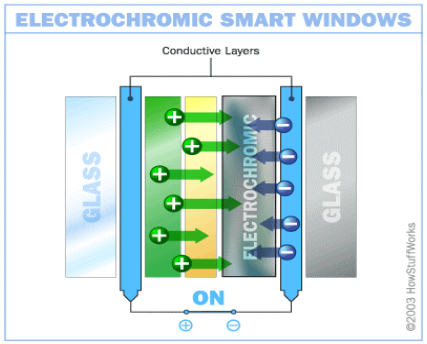
Polymer Dispersed Liquid Crystal (PDLC)



PLC alignment in an electric field

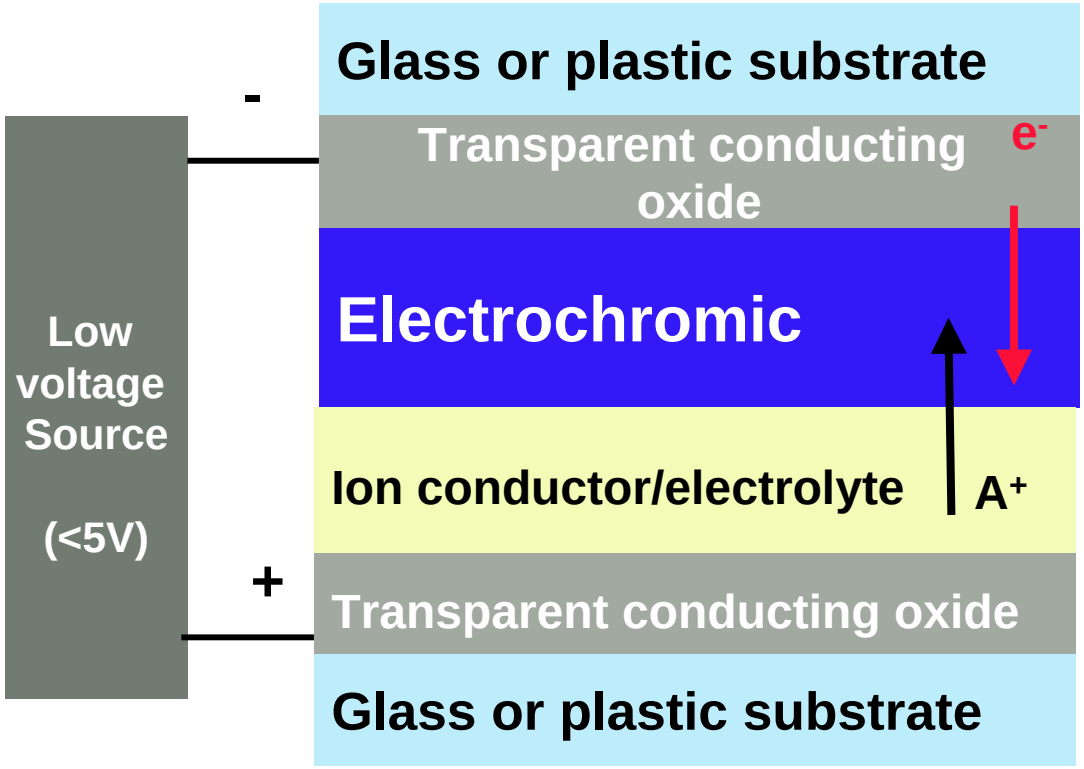
Electrochromic Device (ECD)





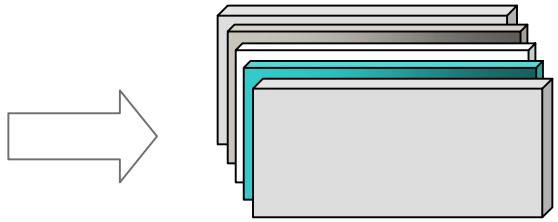
Ion migration into EC layer through a ceramic or gel

Conventional Electrochromic Device (ECD)



Electrochemical battery

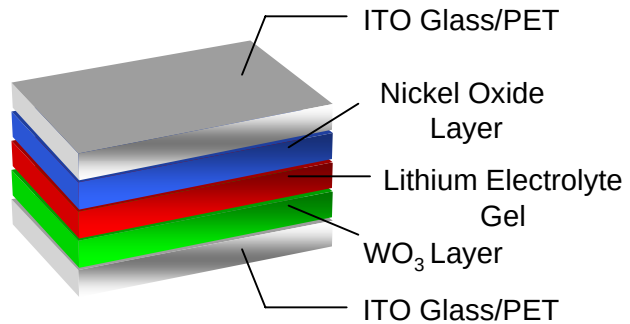
Multilayer complex structure with liquid or gel electrolyte



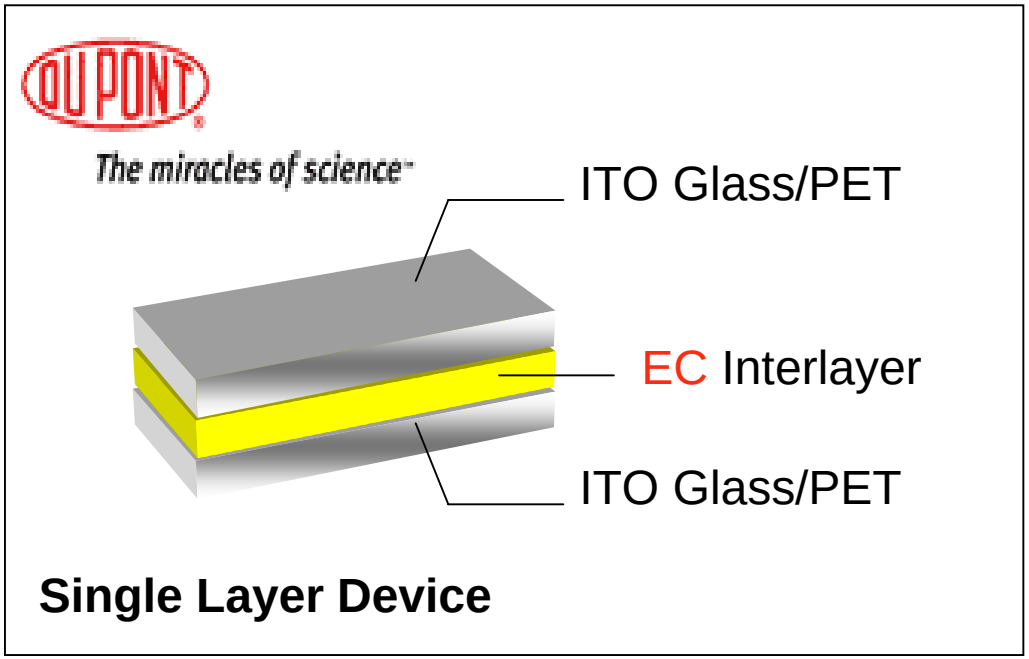
Technical Target: A Unique Product Offering from DuPont

From Current Technology to a Polymer-Based Interlayer that Directly Incorporates the EC Functionality

Current Technology



Multilayered Device



Single Layer Device

- Less complex
- Important cost advantage

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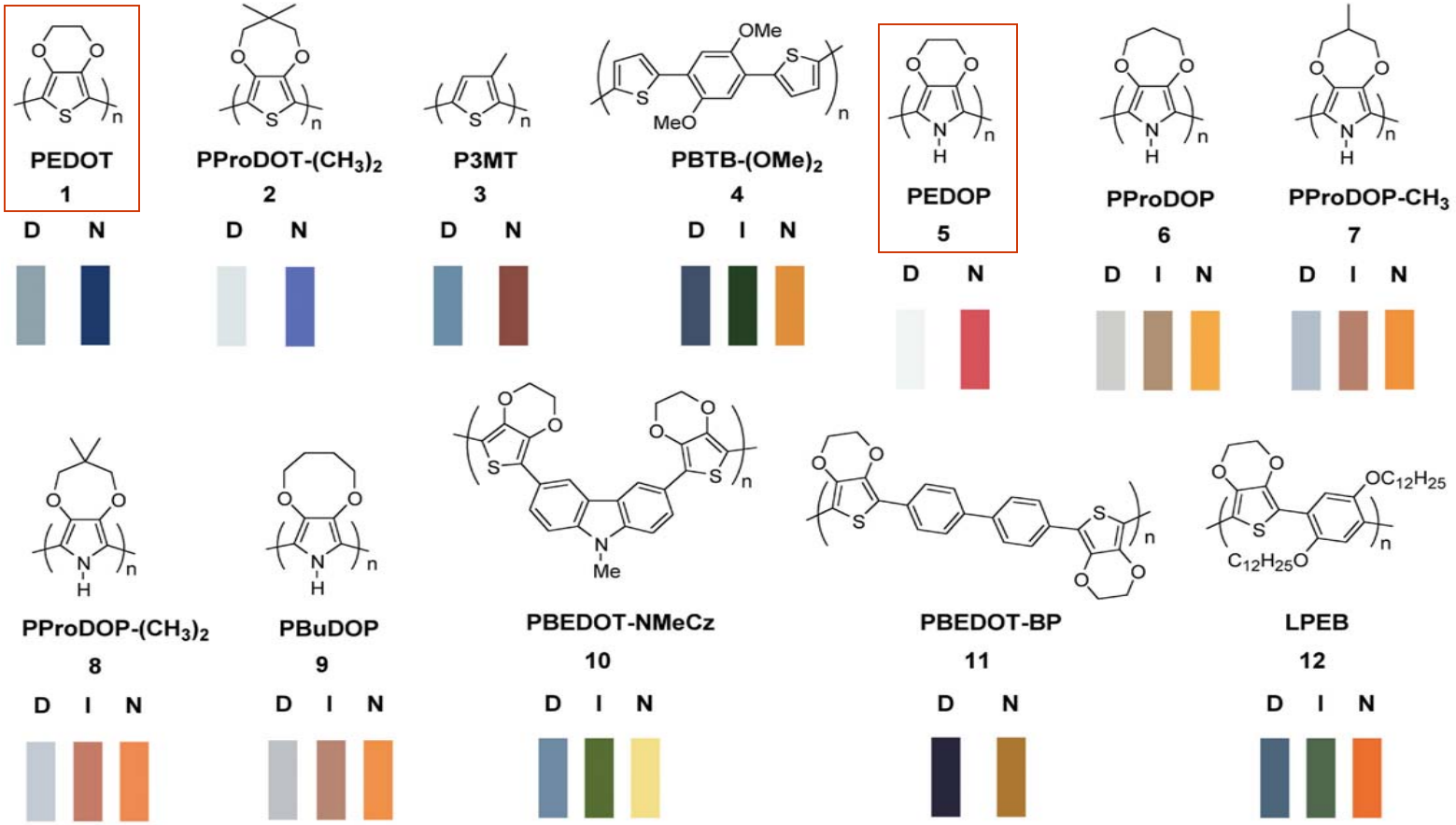
EC Interlayer Consists of Organic Materials

Wide variety of colors *possible via structural modification*

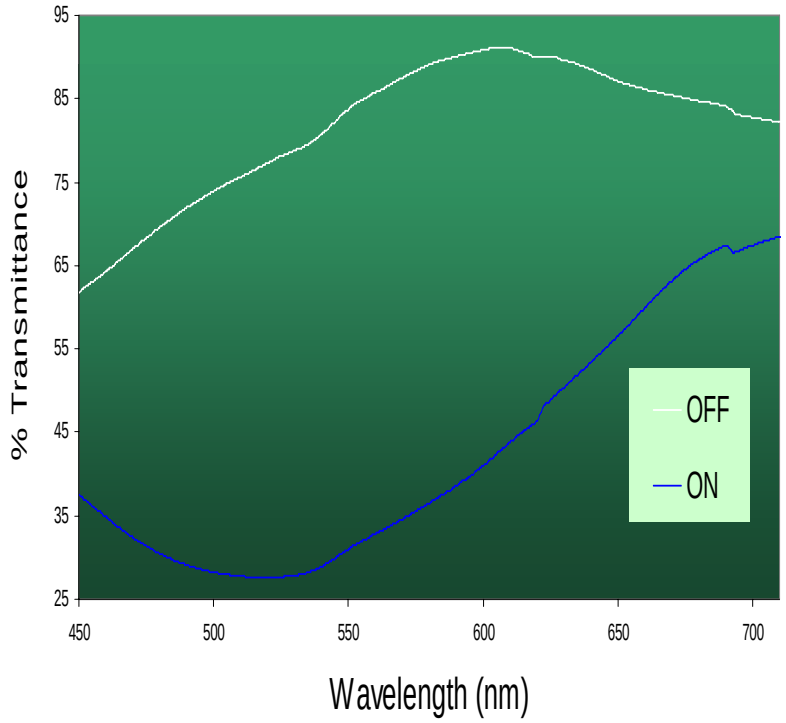


D = doped state (oxidized or reduced); **N** = neutral state; **I** = intermediate state (if any)

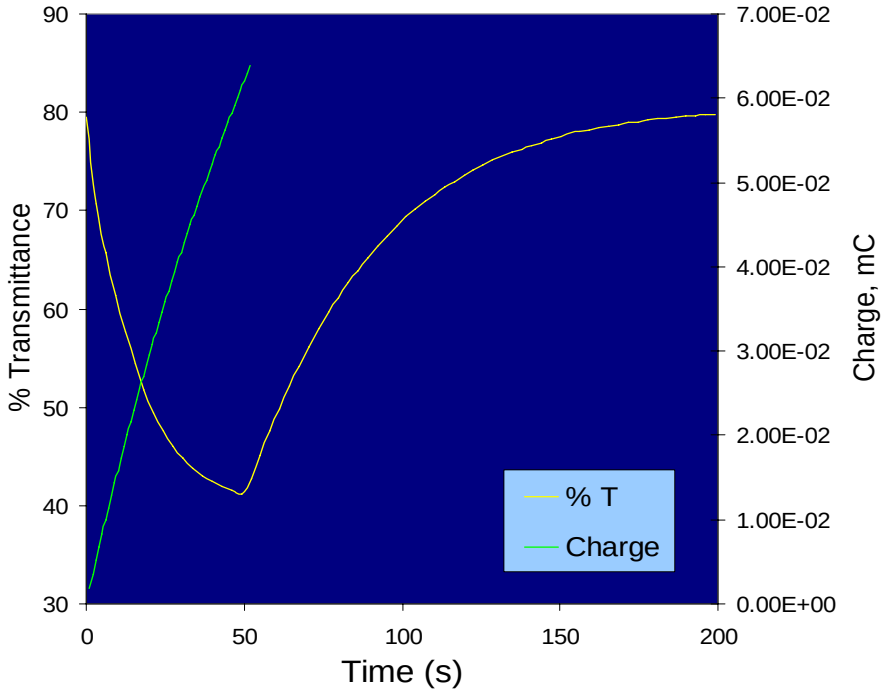
Reynolds et al., Chem. Mater. 2000, 12, 1563.

Typical Light Transmittance Properties

% Light transmittance in OFF and ON states through visible range

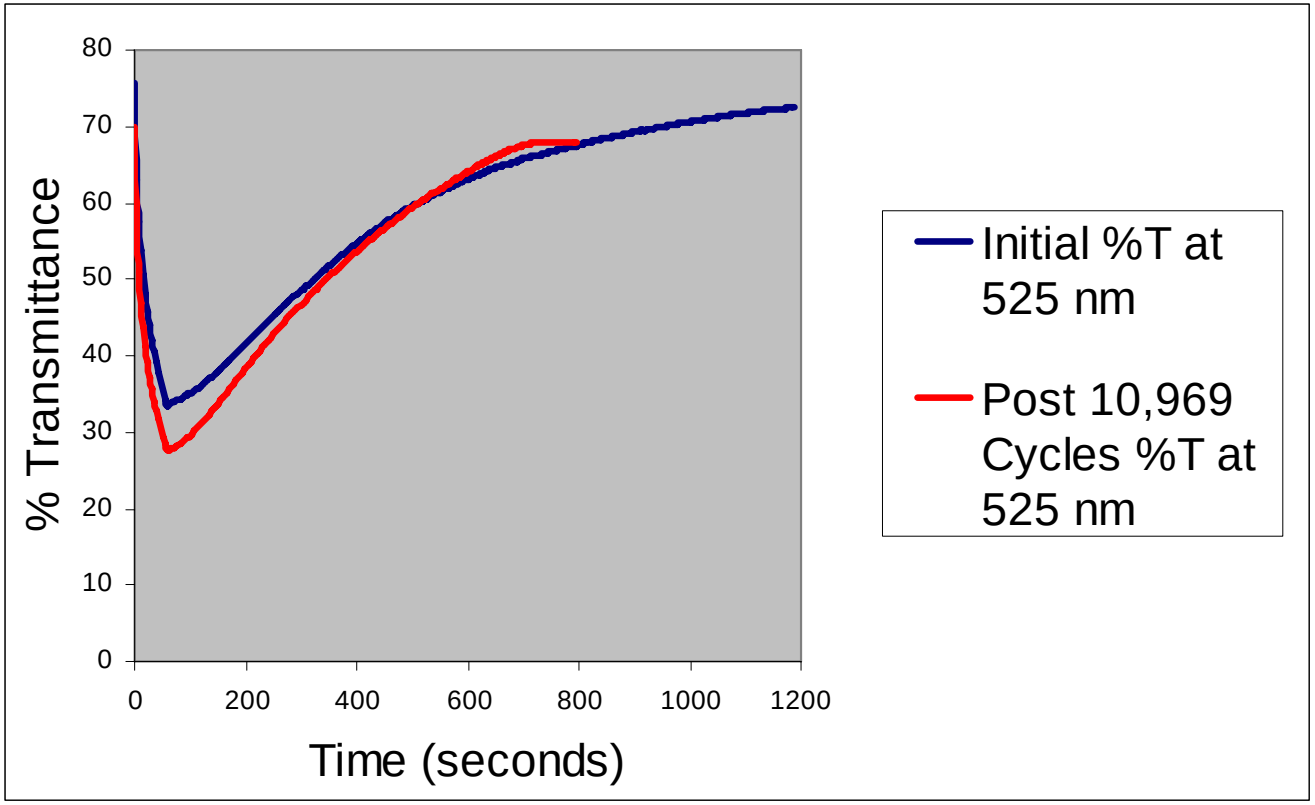


% Light transmittance in OFF and ON states *vs.* time (525 nm)



Light Transmittance and Cyclability

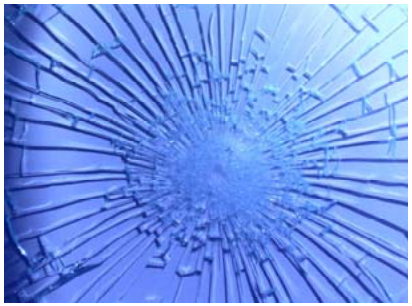
Accelerated 10,000 Life-Cycle Test

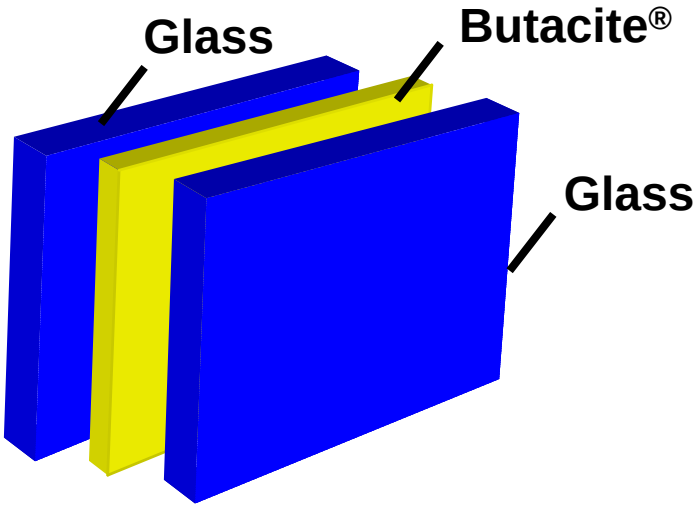


Light Transmittance (%) before cycling (blue) and after more than 10,000 cycles (red)

Integration of Butacite® Laminate and EC Technologies

DUPONT BUTACITE® Polyvinyl Butyral Resin Sheeting





- **Holds glass together**
- **Prevents penetration of objects**
- **Added Functionality:**
  - Sentryglas® Plus
  - Sentryglas® Expressions
  - Sentryglas® Acoustic
  - Spallshield®

ECD Prototype

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EC Applications

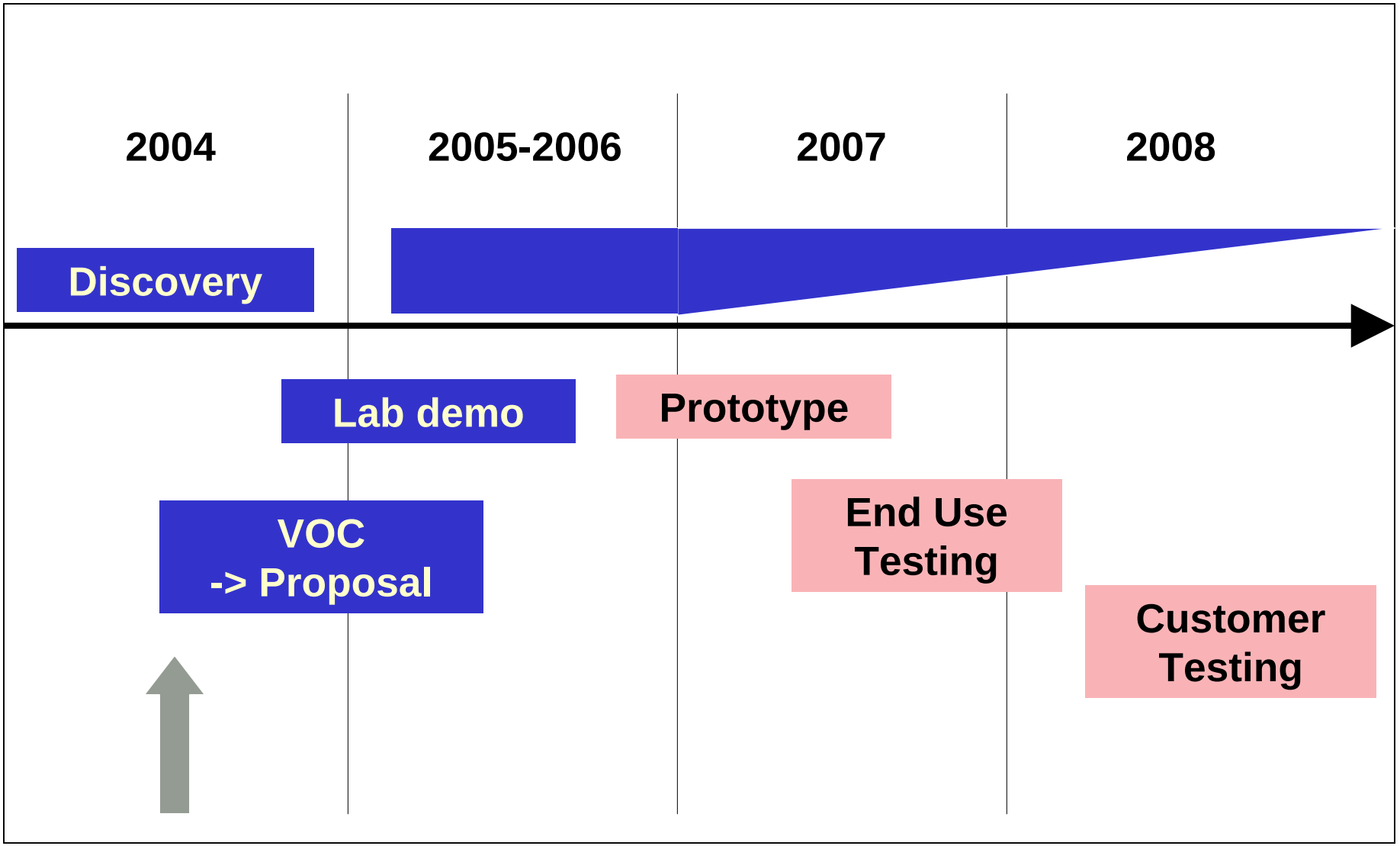
Generation 1

EC Mirrors

Generation 2

Sunroofs with DuPont Glass Laminating Solutions

Timeline


2004
2005-2006
2007
2008
Discovery
Lab demo
Prototype
VOC
-> Proposal
End Use
Testing
Customer
Testing