LightShield: Electrochromatic Windshield

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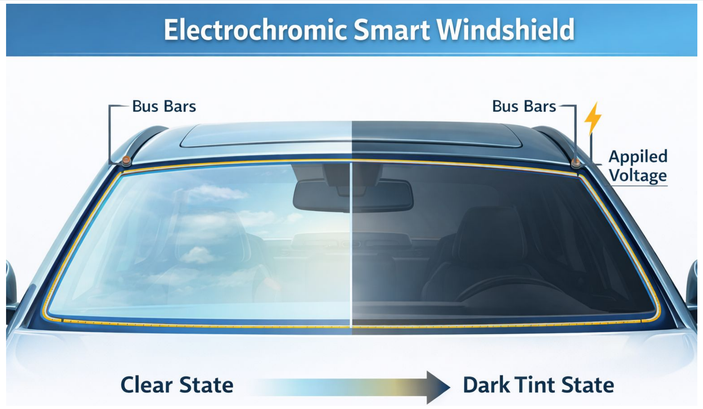
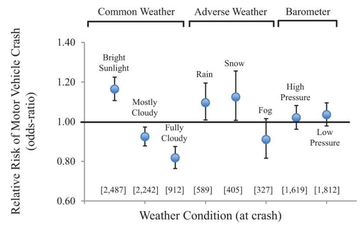
Product Overview



Motivation: Risk of motor vehicle crashes increase by 16% in sunny conditions due to impairment of visibility[1]



Technical Details

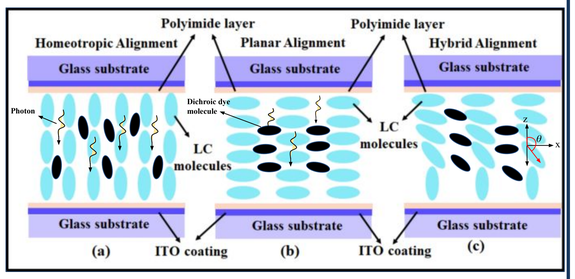
Guest-Host Liquid Crystal (GHLC) Film Layer

1D Ericksen-Leslie nematic continuum with dichroic dye

Governing torque balance for liquid crystal (LC) director angle:

$$\gamma_1 \frac{\partial \theta}{\partial t} = K_{33} \frac{\partial^2 \theta}{\partial z^2} + \frac{1}{2}\varepsilon_0 |\Delta\varepsilon| E^2 \sin(2\theta)$$

γ_1: rotational viscosity
K_{33}: Frank elastic bend constant[4]
ε_0: permittivity of free space
$\Delta\varepsilon = \varepsilon_{||} - \varepsilon_{\perp}$: relative dielectric anisotropy of the LCs
E = V/d: electric field across ITO layers given applied voltage V and gap d.



LC alignment states: (a) homeotropic (OFF, $\theta = \theta_0$) **(b)** planar (ON, $\theta = \theta_{final}$) **(c)** hybrid alignment during rotation ($\theta = \theta(t)$)[6]

Operating voltage:

$$V_c = \pi \sqrt{\frac{K_{33}}{\varepsilon_0 |\Delta\varepsilon|}}$$

→ Minimum voltage to reorient LCs

Response time for tint to turn on/off:

$$t_{on} \approx \frac{\gamma_1 d^2}{\varepsilon_0 |\Delta\varepsilon| (V^2 - V_c^2)} \ln\left(\frac{\theta_{final}}{\theta_0}\right) \qquad t_{off} \approx \frac{\gamma_1 d^2}{\pi^2 K_{33}} \ln\left(\frac{\theta_{final}}{\theta_0}\right)$$

→ determines layer gap d

Concentration of Dichroic Dye:

$$c = \frac{log_{10}(T_{min}/T_{max})}{(\Delta\chi) d}$$

→ To achieve min and max visible light transmission (VLT) of T_{min} and T_{max}

Business and Legal Timeline

Phase 1: R&D
YR 0
Identify key safety metrics
Model ready for deployment

Phase 2: Exemption
YR 1.5
Petition NHTSA for exemption from tinting standards
File 49 CFR § 555.6(b) application

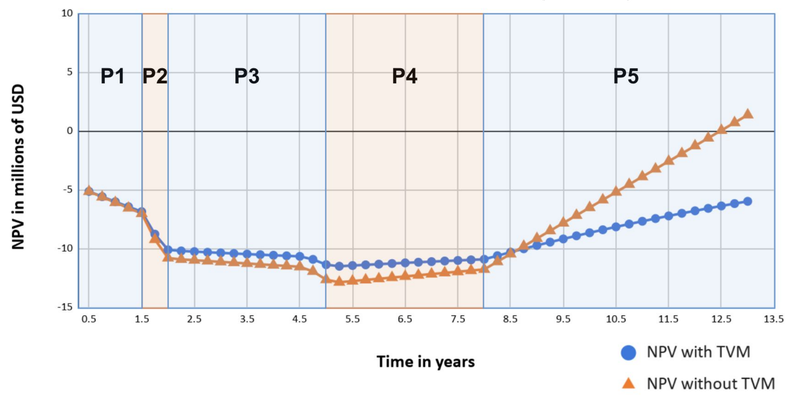
Phase 3: Data Collection
YR 2
OH, HI, ND allow up to 70% full tint
Run controlled trials

Marketing
Demo tech at Consumer Electronics Show (CES) to build investor support and partnerships

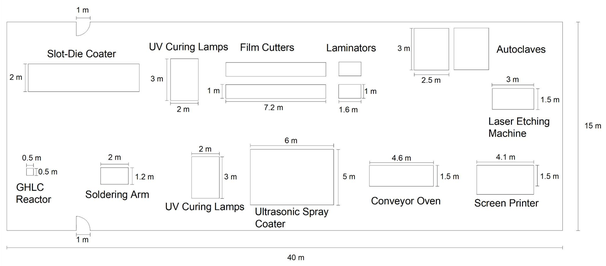
Phase 4: Legal Proposal
YR 5
File NPRM
Petition ANSI Z26.1
Prove noncompliance has no safety impact
Tinting standards amendment

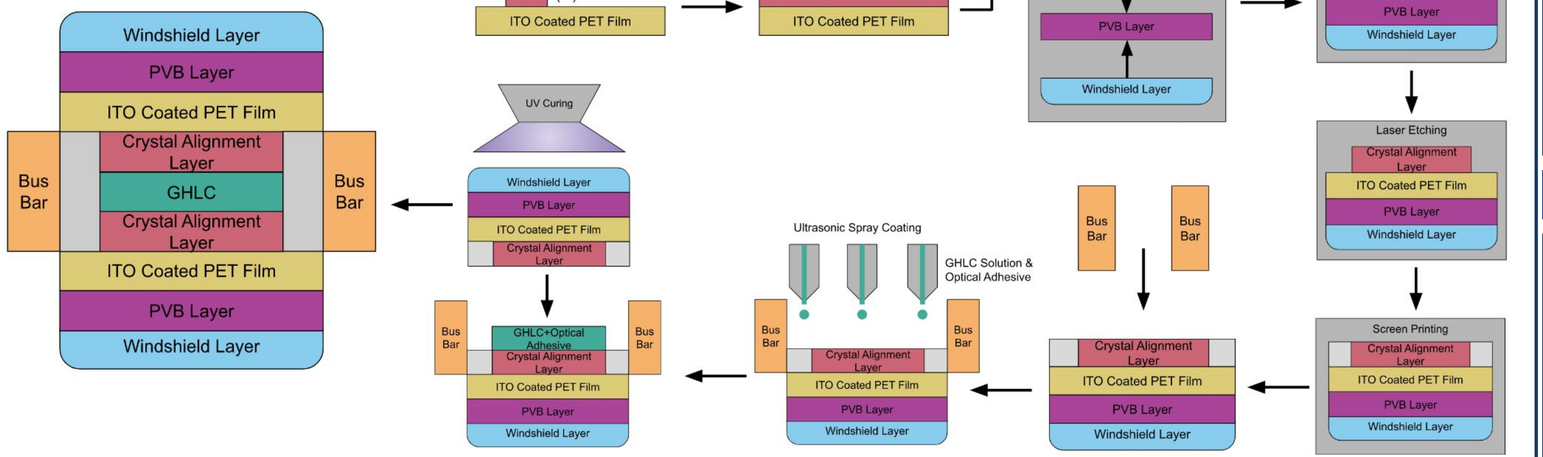
Phase 5: Expansion
YR 6
Legalize state by state
Increase market pull

Net Present Value (NPV)



Manufacturing Process and Layout





References/Acknowledgements

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