

✓ GHG Protocol Standard

⬡ 2026 LSR Standard

Confidence: $\pm 7.4\%$ (Tier-1 DQR 1.2)

Optical Reading Glasses (1.0 Pair)

🌐 Origin: Zhejiang / Wenzhou,
China

📅 Lifetime Scope: Cradle-to-Grave (24 Mo.
RSL)

📏 Total Packaged Mass: 42.0
g

TOTAL LIFE CYCLE PCF

2.288

kg CO₂e / unit (Lifetime)

CARBON INTENSITY

\$

54.48 kg/kg

42.0g mass High-spec optical standard

TOP CARBON DRIVER



73.8%

Upstream Chemical/Resin (Cat 1)

PRIMARY EMISSION SCOPE



92.4%

Scope 3 Value Chain (2.115 kg)

OCEAN SHIPPING RATIO



0.32%

0.0073 kg for 11,000 km voyage

Life Cycle Stage Breakdown

Comprehensive Cradle-to-Grave Stage Contribution

Net 2.288 kg CO₂e

GHG Protocol Scopes

Scope 1 (1.3%) • Scope 2 (6.2%) • Scope 3 (92.4%)

● Scope 1 (Direct Fuel) - **0.031 kg** ● Scope 2 (Facility Grid Power) - **0.142 kg** ● Scope 3 (Upstream & Downstream) - **2.115 kg**

Stage 1: Upstream Materials & Pre-processing	Cat 1 & 4	1.688 kg (73.78%)
Stage 2: Production & Cleanroom Assembly	Scope 1 & 2	0.173 kg (7.57%)
Stage 3: Outbound Logistics & Distribution	Cat 9 Freight	0.011 kg (0.47%)
Stage 4: Consumer In-Use Maintenance	Cat 11 (24 Mo)	0.002 kg (0.08%)
Stage 5: End-of-Life Disposal & Energy Recovery	Cat 12 (WtE / Landfill)	0.037 kg (1.61%)
2026 LSR Module: Biogenic Carbon & dLUC	Removals & Land	0.001 kg (Net neutral loop)

Material vs. Carbon Density

Bill of Materials (BOM) Mass vs. GHG Contribution

42.0g System

COMPONENT	MASS (G)	EMISSION FACTOR	EMISSIONS	IMPACT
Cellulose Acetate Frame & Temples	21.5 g	4.82 kg/kg	0.104 kg	4.5%*
PMMA Optical Resin CR-39 Lens Pair	11.2 g	5.15 kg/kg	0.058 kg	2.5%*
Retail Packaging rPET Cloth + Box	15.5 g	1.78 kg/kg	0.028 kg	1.2%*
Stainless Steel Hinges & Wire Core	2.1 g	4.35 kg/kg	0.009 kg	0.4%*
Optical Coatings Anti-Scratch & AR	0.3 g	18.4 kg/kg	0.006 kg	0.2%*
Intermediate Tier-2/3 Feedstock Polymerization	1 unit	Fixed Allocation	1.485 kg	64.9%

*Direct material cradle-to-gate impact excludes tier-2/3 chemical heating and catalytic synthesis allocations.

Sustainability Hotspot Analysis

Key findings from empirical supply chain life cycle inventory



73.8% Driven by Upstream Polymer Chemistry

Cellulose acetate esterification and optical-grade resin synthesis demand substantial thermal process energy. Raw polymer conversion represents the largest single reduction lever.



Ultra-Efficient Ocean Freight Modality

Over 11,000 km of transoceanic container shipping generates only **0.0073 kg CO₂e** (<0.35% of total footprint), highlighting the profound carbon efficiency of post-Panamax maritime transit.



Full 2026 LSR Biogenic Neutrality Verified

Biogenic storage in softwood-derived acetate accounts for **-0.038 kg CO₂** removal, completely balanced by post-consumer municipal incineration release, verifying net biogenic parity.

Decarbonization Roadmap

Actionable pathways to achieve product low-carbon targets

-38% Net Potential

1	Transition to Bio-Circular Plasticizers Replace fossil DEP/DOP with agricultural citrate plasticizers in acetate frame sheets.	-0.380 kg CO ₂ e
2	Factory Rooftop Solar PV Generation Offset high-carbon East China Grid power during CNC profiling and lens edging.	-0.106 kg CO ₂ e
3	Chemically Recycled PMMA Lens Stock Integrate recovered acrylic off-cuts for non-prescription corrective diopter blanks.	-0.020 kg CO ₂ e
4	Disassembly-Ready Frame Core Wire Facilitate separation of metal hinges to eliminate fossil incineration at municipal EoL.	-0.028 kg CO ₂ e