PRECISION OPTICAL POLYMER ENGINEERING REPORT

Optical Grade Liquid Silicone Rubber (LSR) for Precision LED Lenses

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1. Executive Summary & Optical Clad Evolution

In high-flux LED secondary optics, high-power architectural lighting arrays, and automotive matrix adaptive driving beam (ADB) optical assemblies, the performance of localized light transmission matrices defines system efficiency. Historically, thermoplastic polymers such as Polymethyl Methacrylate (PMMA) and Polycarbonate (PC) served as the standard selections for injection-molded secondary lens arrays. However, modern dense luminaire systems subject lens configurations to continuous thermal stresses exceeding 110°C alongside intense UV radiation flux fields.

Under these operating baselines, thermoplastics experience rapid molecular degradation, resulting in yellowing, thermal micro-cracking, and dramatic transmission degradation. Reemane engineered the RM-OP optical liquid silicone rubber series to surpass these limitations, providing an amorphous, cross-linked siloxane matrix that preserves pristine refractive stability under severe environmental stresses.

> ***Optical Component Directive: PMMA and PC rely on linear polymer structures prone to thermal yellowing; optical LSR utilizes a dense, inorganic Si-O cross-linked backbone immune to standard thermal aging blocks.***

2. Refractive Performance & Yellowing Index Resistance

The core capability of the RM-OP series lies in its exceptional optical clarity, registering a total luminous transmittance of **≥94%** across the visible spectrum (400nm to 800nm) at a standard 2.0mm test thickness. This high transmission is achieved by maintaining a tightly controlled molecular weight distribution that limits internal Rayleigh scattering losses.

The refractive index (n_D) sits at an optimal 1.41 to 1.54, accompanied by an Abbe number of approximately 50 to 55, confirming low chromatic aberration profiles. Under continuous UV radiation exposure (simulated via 1000 hours of intense UVB solar cycling), standard polycarbonate exhibits an unacceptable Yellowing Index (YI) spike past 15. The RM-OP formulation maintains an immutable YI value of **≤1.0**, preventing spectrum shifting in localized optical focus pathways.

3. LSR Liquid Injection Molding Dynamics for Micro-Lens Arrays

Manufacturing precision optical lenses with complex free-form geometric parameters requires highly precise processing kinematics. Thermoplastic injection molding introduces frozen-in structural shear stresses, resulting in internal birefringence patterns that skew polarized light paths. Optical Liquid Silicone Rubber (LSR) utilizes liquid-phase injection delivery via cooled cold-runner networks into heated mold cavities, establishing zero-shear vulcanization parameters that yield completely **birefringence-free isotropic components**.

Due to the exceptionally low viscosity of raw liquid components at room temperature, mold parting lines must be engineered to severe limits. Reemane utilizes hard-chrome plated S136 hardened tool steel blocks machined down to mirror-finish tolerances to eliminate flashing artifacts. Micro-lens arrays featuring high-definition anti-reflective texturing are directly replicated via the low surface tension of the flowing LSR during the active filling cycle.

4. Comprehensive Mechanical & Optical Specifications

Technical Parameter Index	Testing Protocol	RM-OP-70 (Elite Clarity)	Standard Automotive PC
Luminous Transmittance (2mm)	ASTM D1003	**≥ 94%**	89% - 91%
Refractive Index (n_D @ 25°C)	ASTM D542	1.41 / 1.53	1.58
Yellowing Index (YI @ 1000h UV)	ASTM E313	**≤ 1.0**	**≥ 14.5**
Continuous Thermal Threshold	Internal Lifetime	-40°C to +150°C	-30°C to +120°C
Hardness (Durometer)	ASTM D2240	72 Shore A	85 Shore D
Tensile Strength	ASTM D412	6.8 MPa	65 MPa
Linear Mold Shrinkage	ASTM D955	1.8% - 2.2%	0.5% - 0.7%

5. Mold Surface Demands & SPI A-1 Mirror Micro-Polishing

To preserve unhindered total internal reflection (TIR) metrics along secondary optical lenses, mold surfaces must strictly mirror the final desired part texture. Reemane executes comprehensive **SPI A-1 diamond micro-polishing routines** across all active cavity inserts. This processing ensures a surface roughness (R_a) below 0.012 microns, completely eliminating diffraction grating defects.

Furthermore, because vulcanized optical LSR is flexible, components with complex deep undercut configurations can be demolded via mechanical stripping or air-blast assistance without requiring expensive, multipart slider systems. This flexural stripping capability dramatically limits tool complexity and optimizes hourly shot-cycle yield.

Optimize Your Precision LED Secondary Optics

Eliminate thermal yellowing, eliminate internal birefringence lines, and upgrade your light extraction efficiency across automotive matrix ADB units, street luminaires, and industrial high-bay lens blocks. For custom tool engineering support, sample prototypes, or optical LSR material datasheets, contact our specialized engineering team at **sales@siliconefactories.com** or explore our platform at **www.siliconefactories.com**.