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**Proses Manufaktur Lensa Resin Epoksi dan Studi Komparatif Performa Optik Lensa Resin Epoksi dengan
Lensa Akrilik pada Sistem Monokular Galilean**
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INTISARI

Kebutuhan instrumen optik yang ringan dan ekonomis mendorong eksplorasi material polimer alternatif untuk lensa. Resin epoksi Bisphenol-A menawarkan potensi indeks bias yang lebih tinggi dibandingkan akrilik (PMMA), tetapi karakteristik manufaktur dan performa optiknya sebagai lensa *custom* belum banyak dikaji. Penelitian ini mengkaji kelayakan resin epoksi Bisphenol-A sebagai lensa objektif alternatif pada sistem monokular Galilean.

Lensa resin epoksi (Eposchon EPR174 + EPH555, rasio 2:1) diproduksi melalui *vacuum-centrifugal casting* dengan *planetary centrifugal mixer* (pengadukan 240 RPM, degassing 2200 RPM) dan *vacuum chamber* (0,9 bar) menggunakan cetakan silikon RTV-52 tipe *open-face*. Karakterisasi mencakup analisis gugus fungsi (FT-IR), kekerasan permukaan (Shore D), indeks bias dan bilangan Abbe (metode prisma, laser 405/532/650 nm), *Contrast Transfer Function* (CTF) berbasis target USAF 1951, *Lateral Chromatic Aberration* (LCA), serta deviasi panjang tabung, dengan lensa PMMA komersial sebagai pembanding.

Manufaktur berhasil menghasilkan lensa dengan zona optik aktif mendekati bebas gelembung dan akurasi dimensi baik (deviasi maksimum 1,90% terhadap nominal 31,1 mm). Resin epoksi (Epoksi 3) memiliki indeks bias lebih tinggi (nd = 1,5650) dibandingkan PMMA (nd = 1,4904), tetapi bilangan Abbe yang jauh lebih rendah (Vd = 19,20 vs. 53,18) mengklasifikasikannya sebagai material *Flint* berdispersi tinggi. Akibatnya, kontras lensa epoksi 3–5× di bawah PMMA, *limiting resolution* ≤ 0,891 lp/mm (PMMA ≥ 1,782 lp/mm), dan LCA 112,7 µm (PMMA 11,8 µm). Integrasi ke sistem monokular Galilean tetap berhasil melalui mekanisme selongsong *sliding* aksial berbasis *optical error budgeting* sehingga menghasilkan citra tegak yang fungsional. Resin epoksi dinilai layak sebagai lensa objektif alternatif, dan konfigurasi *achromatic doublet* epoksi–PMMA direkomendasikan untuk penelitian lanjutan.

Kata kunci : resin epoksi, PMMA, monokular Galilean, indeks bias, bilangan Abbe, aberasi kromatik lateral, Contrast Transfer Function

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ABSTRACT

The demand for lightweight and economical optical instruments has driven the exploration of alternative polymer lens materials. Bisphenol-A epoxy resin offers a potentially higher refractive index than acrylic (PMMA), yet its manufacturing characteristics and optical performance as a custom lens remain underexplored. This study investigates the feasibility of Bisphenol-A epoxy resin as an alternative objective lens in a Galilean monocular system.

Epoxy resin lenses (Eposchon EPR174 + EPH555, 2:1 ratio) were produced via vacuum-centrifugal casting using a planetary centrifugal mixer (240 RPM mixing, 2200 RPM degassing) and a vacuum chamber (0.9 bar) with an open-face RTV-52 silicone mold. Characterization included FT-IR analysis, surface hardness (Shore D), refractive index and Abbe number (prism method, 405/532/650 nm lasers), Contrast Transfer Function (CTF) using a USAF 1951 target, Lateral Chromatic Aberration (LCA), and tube length deviation, with commercial PMMA lenses as the benchmark.

Manufacturing successfully produced lenses with an optical zone nearly free of bubbles and good dimensional accuracy (maximum deviation of 1.90% against the 31.1 mm nominal). The selected epoxy (Epoxy 3) exhibited a higher refractive index (nd = 1.5650) than PMMA (nd = 1.4904), but a substantially lower Abbe number (Vd = 19.20 vs. 53.18), classifying it as a Flint-type material with high dispersion. Consequently, its contrast was 3–5× lower than PMMA, the limiting resolution was ≤ 0.891 lp/mm (PMMA ≥ 1.782 lp/mm), and the LCA was 112.7 µm (PMMA 11.8 µm). Integration into the Galilean monocular system was nonetheless achieved through an axial sliding sleeve mechanism based on the optical error budgeting concept, producing a functional erect image. Epoxy resin is deemed viable as an alternative objective lens, and an epoxy–PMMA achromatic doublet configuration is recommended for future research.

Keywords *: epoxy resin, PMMA, Galilean monocular, refractive index, Abbe number, lateral chromatic aberration, Contrast Transfer Function*