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How should a beam splitter be manufactured



Overview

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Key Takeaways

The manufacturing of a beam splitter involves precision material selection, shaping, polishing, coating, assembly, and rigorous optical testing to ensure high performance.Material Selection

The process begins with choosing high-quality optical materials such as BK7 glass, fused quartz, or calcium fluoride, depending on the intended wavelength range (ultraviolet, visible, or infrared) and application requirements . The raw material is inspected for internal uniformity, stress, and defects like bubbles or streaks using laser interferometers and spectrophotometers to ensure optical purity .

Cutting and Shaping

The selected material is cut into the approximate shape of the beam splitter using diamond saws or precision cutting tools. For cube beam splitters, two triangular prisms are prepared, while for plate or polarizing prisms, rectangular blanks are cut . The size tolerance is carefully controlled to minimize material loss and ensure proper alignment in later stages.

Grinding and Polishing

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The prism surfaces are precision-ground to achieve the required flatness and angular accuracy. Polishing follows to reduce surface roughness, minimize light scattering, and improve optical clarity. This step is critical for maintaining low optical loss and high stability .

Coating

Optical coatings are applied to enhance performance. This may include anti-reflection coatings, reflective metallic layers (e.g., aluminum), or multi-layer dielectric films. For polarizing beam splitters, coatings are designed to reflect S-polarized light while transmitting P-polarized light with high extinction ratios . Coating thickness and uniformity are precisely controlled using vacuum deposition techniques.

Assembly

For cube beam splitters, the two prisms are glued together using optical adhesives such as epoxy or urethane-based resins, with the adhesive layer thickness adjusted to achieve the desired splitting ratio . Polarizing prisms may use adhesive-free bonding methods like van der Waals force or low-temperature varnish to avoid stress-induced optical distortions .

Testing and Calibration

Finally, each beam splitter undergoes rigorous testing using spectrometers, interferometers, and other optical measurement tools to verify splitting ratio, transmittance, reflectance, and polarization performance. Only components meeting strict specifications are approved for use in applications such as spectroscopy, laser systems, imaging, and interferometry . This multi-step process ensures that beam splitters achieve high precision, low loss, and long-term stability, which are essential for advanced optical systems.

Article Content

Beam splitter

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In its most common form, a cube, a beam splitter is made from two triangular glass prisms which are glued together at their base using polyester, epoxy, or urethane-based adhesives. (Before these synthetic resins, natural ones were used, e.g. Canada balsam.) The thickness of the resin layer is adjusted such that (for a certain wavelength) half of the light incident through one "port" (i.e., face of the cube) is reflected and th

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