Integral Flexure Mounts for Metal Mirrors for Cryogenic Use

These mounts are compact and relatively inexpensive.

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Semi-kinematic, six-degree-of-freedom flexure mounts have been incorporated as integral parts of metal mirrors designed to be used under cryogenic conditions as parts of an astronomical instrument. The design of the mirrors and their integral flexure mounts can also be adapted to other instruments and other operating temperatures. In comparison with prior kinematic cryogenic mirror mounts, the present mounts are more compact and can be fabricated easily using Ram-EDM (electrical discharge machining) process.

The mirrors are designed to be mounted on an optical bench. To prevent bimetallic stresses that would arise during heating and cooling between room temperature (≈293 K) and the operating temperature of 80 K, both the optical bench and the mirrors are made of aluminum alloy 6061. Also, the mirrors and the bench are subjected to stress-relief treatments during fabrication to reduce figure errors and alignment changes that could arise upon cooling from room temperature to the operating temperature.

Each mirror has a width-to-thickness ratio of about 6 and is made from a 6061 aluminum alloy substrate. Three tablike flexures (mounting tabs) are machined into the rear of the substrate, which is diamond-machined flat to optical tolerances. The mounting tabs flex in six degrees of freedom, minimizing distortion caused by mounting the mirror on the bench. A large, thin, one-piece shim is placed between the rear surface of the mirror and the bench. The bench interface surface and the bench side of the shim are lapped flat for smooth, repeatable placement. Three thin, raised bosses that are flat and coplanar to within tight tolerances rise from the mirror side of the shim to meet the tabs. For changes in alignment, the bosses are machined such that the mirror substrate is always approximately parallel to the plane that the bosses define. Therefore, the tabs do not bend in response to changes in alignment, but flex only to accommodate coplanarity errors in the machining of the three shim bosses. Ideally, no tab should ever be made to flex more than ±0.025 mm in translation, but the tabs are designed to yield an acceptable figure error for displacements of as much as ±0.125 mm in all three translational degrees of freedom and/or ±0.1° in all three rotational degrees of freedom.

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