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Fabrication and testing of the 3.5 m, f/1.75 WIYN primary mirror.

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1. Abstract.

The continuing development of rapid fabrication methods for large optics at the Steward Observatory Mirror Lab has resulted in the completion of the WIYN 3.5 m primary mirror in only five months. The use of these methods, though rapid, also resulted in one of the best surface figures we have produced (16 nm rms), excellent microroughness (8 angstroms rms), and very smooth small-scale figure error as determined by the structure function of the surface errors. In this paper, we review the important techniques in the grinding, polishing, and testing of the mirror used to achieve these results.

2. Introduction.

2.1 Mirror design.

The WIYN telescope is a 3.5 m. Ritchey-Chrétien design with an f/1.75 hyperboloidal primary mirror with a conic constant of -1.0708. The primary mirror blank is an Ohara E6, borosilicate, lightweight casting formed in the giant rotating furnace at the Steward Observatory Mirror Lab. Rotation of the furnace during casting allows the liquid glass forming the approximately 28 mm thick faceplate of the mirror to be spun into a curve of very nearly the correct radius of curvature. This eliminates the enormous effort of generating in a curve having 122 mm of sag, not to mention the time and risk involved in annealing such a thick faceplate. Blanks up to 6.5 m. in diameter have been cast using this process.

The blank's honeycomb internal structure incorporates 294 hexagonal cores having a "diameter" of about 175 mm. The walls of the honeycomb are approximately 12 mm thick and both the faceplate and the backplate are about 28 mm thick. The center hole has a diameter of just under 1 m.

2.2. Initial work.

Following the casting, the mirror blank went to the optical shop at NOAO where it was generated, etched, ground, and polished to a good sphere. Extensive testing followed to evaluate the thermal behavior of the mirror as well its mechanical response in the telescope cell where the mirror is supported on 66 active supports. After the initial aspherization at the Mirror Lab with the mirror on a different support the mirror was returned to the telescope cell for final figuring. The active supports during final figuring were replaced with passive supports at the same locations as the active supports. Small differences in the two supports will be removed with the active support system in the telescope.

3. Aspherization

3.1. Stressed-lap grinding.

To introduce the required 171 microns of asphericity from best-fit sphere in a smooth fashion we utilized the unique capabilities of the stressed-lap polisher as a grinding tool.[1,2] Using the stressed-lap as a grinding tool had

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