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Measurement of slope error of a solar dish facet substrate with the optical scanning method and its impact on the light concentration

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Abstract

Solar collectors are necessary optical devices for converting solar irradiation into heat. Their optical characteristics are necessary prior to construction. The construction error and the slope error of the surface mirror facet of a parabolic solar collector have been measured by the optical scanning method. The material of the mirror layer is reinforced fiberglass, which is designed and made by molding method and its approximate area is 0.8 square meters. In the optical scanning method, a structured light mechanism and off-axis imaging are used. In addition to the location of each point, the depth of that point is measured and a cloud is obtained from the surface points of the part. By fitting a parabolic procedure with a focal length of 3,000 millimeters (specified in the design file of the part), the vertical deviation of the measuring points (actual) on the part with the design file points (nominal) was determined. The Root Mean Square geometric difference from point to point of the constructed part compared to the designed part was approximately 1.2 mm. The effect of surface slope error was calculated in terms of the normal vector angular deviation of each point from the ideal surface and the amount of ±15.7 mrad angular deviations was calculated for this procedure. The cloud of points measured by the optical scan was inserted into the Zemax software environment and the focal intensity pattern obtained from this fiberglass procedure was simulated by the Monte Carlo method. Next, a thin layer of the mirror was stuck on the substrate. The temperature profile of the concentrated light on the focal area was measured on an iron plate receiver with a thermal camera and the maximum surface temperature of 140 ° C was recorded.

Keywords: concentrated solar energy (CSE), solar parabolic dish, optical scan, surface error, optical simulation, thermograph camera

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