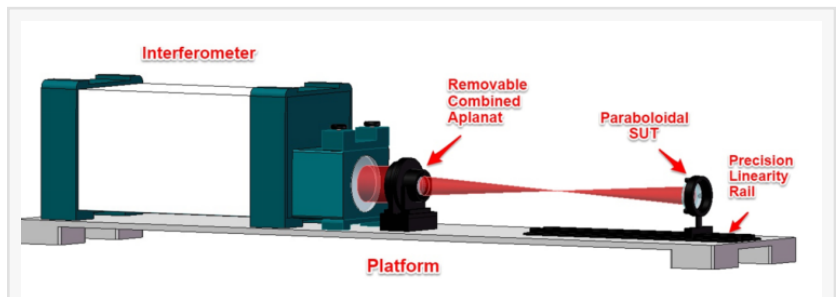


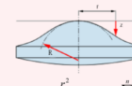
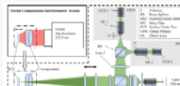

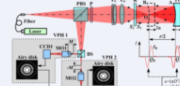
# Measurement techniques for aspheric surface parameters

FAYETTEVILLE, GA, USA, August 1, 2023

/EINPresswire.com/ -- Asphere is a general term for surfaces that deviate from a sphere. [Aspheric](#) surfaces include rotationally symmetric aspheric surfaces, off-axis aspheric surfaces, and freeform surfaces. Aspheric surfaces have higher degrees of freedom than spherical ones, allowing them to achieve more functions than the spherical surface. On the one hand, aspheric surfaces can correct high-order aberrations, thereby obtaining higher imaging quality; on the other hand, one aspheric surface can create effects that are only possible with multiple spherical mirrors, which reduces the size and weight of the optical system. This is important in modern optical systems that need to balance system weight and imaging quality.



Test setup of the interferometric method

<p><b>Direct fitting method</b></p>  <p>Accuracy: High Versatility: High Cost: High</p>	<p><b>Interferometric method</b></p>  <p>Accuracy: High Versatility: High Cost: High</p>
<p><b>Geometrical method</b></p>  <p>Accuracy: Medium Versatility: Medium Cost: Low</p>	<p><b>Center-of-curvature-based method</b></p>  <p>Accuracy: High Versatility: Low Cost: High</p>

Characteristics of the measurement techniques for parameter measurement

The high-precision measurement of aspheric surface parameters is the basis of aspheric surface manufacturing. Professor Hao's research group from Beijing Institute of Technology recently published a review article in [Light: Advanced Manufacturing](#) titled "Measurement techniques for aspheric surface parameters".

This article analyzes the difference between aspheric parameter measurement and surface form measurement, reveals the intrinsic nature of parameter measurement, presents a new classification of the aspheric parameter measurement techniques, and outlines possible future trends and challenges.

Why parameter?

The measurement technique of the aspheric surface is mainly for the surface form and parameters. The surface form is the three-dimensional distribution of the surface in the spatial domain. The measurement result of surface form is a geometric quantity and is often expressed in surface height, which is a function of  $(x, y)$  coordinate with a unit of length. Meanwhile, the aspheric surface parameters (ASPs) are well-defined quantities that can be derived from the surface form. The measurements of surface form and parameters can both assess the aspheric surface quality.

The surface form measurement obtains the deviation in the spatial domain between the surface under test and the design model, which can effectively guide the processing in the optical shop. Theoretically, the optical system can meet the requirements as long as the surface form error of each surface is sufficiently small. However, extremely small surface form errors are rarely required for each surface because such an excessively high processing target will markedly increase the cost. Assigning the exact final processing precision target to each surface is important in manufacturing the aspheric surface.

The parameter measurement obtains the light modulation deviation between the surface under test and the design model, which can effectively assess whether the surface can function as expected in the optical system. The parameter measurement results can provide feedback to the model of the aspherical optical system in the commercial optical design software to determine whether the surface can meet the requirements.

In summary, the surface form measurement provides direction for the processing, while the parameter measurement provides a suitable target for processing.

## Classification

The authors classified the parameter measurement methods into two major categories according to the data processing approach: general fitting and center-of-curvature-based methods.

### 1. General fitting method

If the measured data are directly used to calculate the ASPs, then the methods are classified into the general fitting method category. The general fitting method can measure all aspheric parameters and is commonly used in optical shop testing. The authors classified the general fitting method into three types according to the measurement data source: direct fitting method, interferometric method, and geometrical method.

#### 1) direct fitting method

In the direct fitting method, the aspheric surface form is measured, then the measured data are mathematically fitted to obtain the ASPs. This method is widely used due to the maturity of surface form measurement techniques. However, accurately measuring the aspheric surface form is expensive and inefficient.

## 2) interferometric method

Interferometry is an efficient optical method with superior traceability that has been widely used to test optical aspheric surfaces. Nevertheless, the interferometric setup is complicated, the test cost is high, and the measurement range is relatively small.

## 3) geometrical method

Compared with the interferometric method, the geometrical method lacks traceability. But this method is simple in structure and has a large measurement range.

## 2. Center-of-curvature-based method

If the measured data are used to position the corresponding center of curvature, then the methods are classified into the center-of-curvature-based method. The center-of-curvature-based method can measure the radius of curvature of a quadratic aspheric surface with high accuracy but cannot measure the high-order coefficients of an aspheric surface, which means this method has poor versatility.

## 3. Outlook

With the gradual maturity of aspheric surface measurement methods, the direct fitting method has been widely used in aspheric surface parameter measurement due to its high accuracy and versatility. And the interferometric method, geometrical method, and center-of-curvature-based method have different advantages in test accuracy, versatility, and cost control.

For the past decades, we have been delighted to see the booming development of this area that there are different efficient approaches for different ASUTs in various test scenarios. Nevertheless, the development of advanced optics always poses new challenges. Further progress will undoubtedly be associated with a test method comprehensively considering high accuracy, low cost, and good versatility.

## References

DOI

10.37188/lam.2023.019

## Funding information

This work was supported by the National Key R&D Program (2021YFC2202404); National Natural Science Foundation of China (51735002); Strategic Priority Program of Chinese Academy of Science (XDA25020317).

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