

Carrying out laser/optical metrology

Overview

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This standard identifies the competences you need to carry out laser/optical metrology, in accordance with approved procedures. You will be required to use high-precision machinery to carry out metrology on optical surfaces. You will be expected to use a variety of methods and techniques. From the process carried out, you will be expected to record metrology data relating to optical surfaces.

Your responsibilities will require you to comply with organisational policy and procedures for the laser/optical metrology activities undertaken, and to report any problems with these activities, tools and equipment used that you cannot personally resolve, or that are outside your permitted authority, to the relevant people. You will be expected to work with a minimum of supervision, taking personal responsibility for your own actions and for the quality and accuracy of the work that you carry out.

Your underpinning knowledge will provide a good understanding of your work, and will provide an informed approach to applying laser/optical metrology procedures. You will understand the various laser/optical metrology methods and techniques used, and their application. You will know how to apply and interpret information obtained from the metrology equipment, in adequate depth to provide a sound basis for carrying out the activities, and identifying faults or conditions that are outside the acceptable specification. You will know about the interaction of the other associated integrated technologies, and will have adequate knowledge to carry out metrology accurately.

You will understand the safety precautions required when carrying out laser/optical metrology activities, in particular those relating to exposure to laser light. You will be required to demonstrate safe working practices throughout, and will understand your responsibility for taking the necessary safeguards to protect yourself and others in the workplace.

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Performance criteria

You must be able to:

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1. work safely at all times, complying with health and safety and other relevant regulations, directives and guidelines
2. follow the correct specification for the product or equipment being inspected
3. use the correct equipment to carry out the inspection
4. identify and confirm the inspection checks to be made and the acceptance criteria to be used
5. carry out all required inspections, as specified
6. identify any defects or variations from the specification
7. record the results of the inspection in the appropriate format
8. deal promptly and effectively with problems within your control and report those that cannot be solved

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Knowledge and understanding

You need to know and understand:

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1. how to work safely at all times, complying with health and safety and other relevant regulations, directives and guidelines
2. the importance of wearing personal protective clothing (PPE) and other appropriate safety equipment during the measurement process, the equipment to be used, and where to obtain it
3. hazards associated with carrying out metrology and how to minimise them and reduce any risks
4. where to obtain, and how to interpret, drawings, specifications, quality control documentation, equipment manuals and other documents needed in the metrology process
5. the importance of checking that all metrology inspection documentation and specifications are current and complete
6. how to extract information from engineering drawings and related specifications (to include codes, symbols and conventions to appropriate standards) in relation to the metrology inspection work being undertaken
7. how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
8. the use of relevant standards for determining if components and products are fit for purpose
9. the general principles of inspection systems and procedures
10. preparations to be undertaken on the components before they are inspected
11. the various optical inspection operations to be performed, and the types of equipment used
12. the importance of ensuring that equipment is set up correctly and is in a safe and useable condition
13. how to handle and store the laser/optical metrology inspection equipment, safely and correctly
14. how to calibrate the equipment before metrology inspection operations are carried out
15. the effects that the environment may have on the measurements taken, particularly where precision measurements are required
16. the need to select and use set datum points, and the effects of taking readings from different datums
17. why sampling is used and when it is an effective means of quality

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- assurance
18. how to evaluate the various types of information available during the metrology process
 19. the procedures to be followed to set up and record the measurements needed
 20. how to use the various aids and reports available for fault diagnosis during the metrology
 21. the typical defects and variations that can be found on the components, and how to identify them
 22. the procedure to be followed when inspected products are out of specification (including obtaining concessions, where appropriate)
 23. the importance of completing inspection documentation; what needs to be recorded and where records are kept
 24. how to prepare a report which describes the measurements undertaken, the algorithms used to process the data and the accuracy of the results obtained
 25. the extent of your own responsibility and to whom you should report if you have problems that you cannot resolve

Scope/range related to performance criteria

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1. Carry out all of the following during the laser/optical metrology activities:
 1. obtain and interpret correctly the documentation for the optical components to be inspected
 2. adhere to procedures or systems in place for risk assessment, personal protective equipment and other relevant safety regulations and procedures to realise a safe system of work
 3. ensure the safe operation of the metrology equipment (such as mechanical or electrical)
 4. check that all tools and test equipment to be used are within their calibration dates
 5. carry out the metrology activities, using approved techniques and procedures at all times
 6. record the measurements of the inspection/metrology checks, as per the operating procedures
 7. return all tools and equipment to the correct location on completion of the metrology activities
 8. leave the metrology equipment and work area in a safe and clean condition on completion of the activities
 9. dispose of any waste items in a safe and environmentally acceptable manner
2. Carry out laser/optical metrology on four of the following types of optical component:
 1. infra-red lens
 2. optical mirrors
 3. infra-red glass domes
 4. optical cylinder
 5. infra-red glass flats
 6. plastic lens components
 7. glass lens
 8. infra-red prisms
 9. flat surface
 10. combiners
 11. profiled optical components
 12. spherical surface
 13. glass prisms
3. Perform a complete metrology method, to include two of the following:
 1. two beam interference

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2. null optic tests (such as Offner test)
 3. Fizeau interferometer
 4. hyperboloid test (such as Meinel test)
 5. Mach Zehnder interferometer
 6. conic tests (such as Hindle test)
 7. Twyman Green interferometer
 8. concave parabolic test
 9. Mirau interferometer
 10. elliptical test
 11. Linnik interferometer
 12. holographic null test
 13. Shack interferometer
 14. testing windows/prisms in transmission
 15. Smartt point diffraction interferometer
 16. autocollimator test
 17. Sommargren diffraction interferometer
 18. interferograms
 19. lateral shear interferometer
 20. scatterplate interferograms
 21. radial shear interferometer
 22. dye laser interferograms
 23. long wavelength interferometer
 24. FECO (fringes of equal chromatic order)
 25. two wavelength holography interferometer
 26. Normarski interferometer
 27. Ritchey-Common test
 28. phase-shifting interface microscope
 29. Shack-Hartmann test
 30. Moiré fringe patterns
 31. cylindrical surface test
 32. Lyot test
 4. Record the metrology data from sources appropriate to the method being used, to include five of the following:
 1. measure power density
 2. using a scanner
 3. record an image of the surface contours
 4. using a CCD camera
 5. perform null testing using compensators
 6. recording of P-V (peak to valley) data
 7. perform tilting to measure sagittal focus
 8. record interferogram images, using software methods
 9. analyse and record interferometric fringe patterns
 10. take measurements and interpret data
 11. record data using detector arrays
 12. using graphics tablets
 5. Use a variety of analytical methods to process the data collected from the metrology method being used, to include five of the following:

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1. direct phase measurement
2. produce slope maps
3. phase measurement calculations
4. analyse P-V and RMS data using computer software
5. carry out diffraction calculations (such as phase shifting and modulation transfer function (MTF))
6. run an algorithm for phase measurement
7. resolve any phase ambiguities
8. resolve error sources for vibration, stray-reflections, detector non-linearity, frequency stability, quantisation errors
9. analysis of synthetic wavefronts
10. perform computer analysis of interferograms
6. Provide a record of the outcome of the metrology process, which should contain all of the following:
 1. step-by-step analytical report
 2. a record of the method chosen and the algorithms used
 3. an analysis of the measurements taken, with associated errors

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