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Design of a dispersive lateral scanning surface profilometer

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1. Introduction
The aim of the research is to develop a laser scanning optical probe for an integrated optics measurement system (figure 1). The metrology tool is based on wavelength scanning and phase shifting interferometry. The optical probe being one of the main constituents of the device, critically determines the performance of the metrology tool in terms of lateral resolution.

![Figure 1: Integrated optic measurement system](image1)

2. Lateral Scanning Probe
A dispersive probe with a diffraction grating as an encoder is used to relate wavelengths into spatial information of the surface under test. The measurement accuracy of the tool depends upon the lateral and axial resolution of the probe system. The use of a grating alleviates the need of any mechanical scanners, which significantly simplifies the probe design and construction. The speed and durability of diffraction grating-based scanners is naturally much higher compared to the mechanical ones.

![Figure 2: Lateral scanning profilometer](image2)

3. Objective
Design and optimisation of a lateral scanning probe for use with a chip tunable laser (1500-1600 nm) as illumination source.

4. Optical Design Simulation
Thorlabs achromatic lenses AC-080-016-C and AC-254-050-C are used as scan lens and tube lens. The objective lens used is K_013 objective from the Zebase catalogue. The grating with line spacing 800lines/mm is used in the design. Zemax optical design software is used for the optical probe design. The system is optimised using the various parameters in the merit function.

![Figure 3: Optical layout](image3)

5. Results and discussion
Spot rays lie well within the airy radius indicating that the diffraction-limited performance is obtained at all the three design wavelengths.

![Figure 5: Simulated spot size diagrams](image5)

6. Future work
- Simulate and optimise a collimated fibre delivery using a collimating lens
- Build and evaluate a bench top prototype for scanning using a suitable optical cage mounting system

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