Title:
(Meta)material Characterisation and Thin-film sensing Using Quasi-optical Technique in Millimetre Wave Band

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Abstract
The work presented in this thesis concerns exploring, developing and analysing methods and algorithms that are applied to material properties characterisation at millimetre frequencies using a quasi-optical technology.

Firstly, the quasi-optical measurement technique is shown and a developed calibration method is presented.

Secondly, a novel extension to the Nicolson-Ross-Wier (NRW) algorithm to calculate the dielectric properties of single-layer materials is illustrated.

Thirdly, the multilayer structure are characterised using two optimisation algorithms: genetic algorithm (GA) and sequential quadratic programming based on the quasi-Newton (Broyden-Fletcher-Goldfarb-Shanno) method (BFGS-SQP). A comparison between their ultimate performance is validated. They have been compared on speed, accuracy and robustness.

After that, developed materials that have a negative refractive index at mm-wave frequency are shown. a simple and accurate analytical $LC$ model is proposed to compute the $LC$ resonant frequency response. The model is verified numerically and experimentally in mm-wave frequency range with a normal incidence illumination. Moreover, the effect of the geometric parameters has been also studied. Finally, The application of these designs to characterise tiny amounts of chemicals and optical sensing is presented.