行政院國家科學委員會專題研究計畫　期中進度報告

遠場下確認次波長尺度變化的方法之研發(1/2)

計畫類別：個別型計畫
計畫編號：NSC94-2215-E-009-036-
執行期間：94 年 08 月 01 日至 95 年 07 月 31 日
執行單位：國立交通大學光電工程學系(所)

計畫主持人：陳志隆

報告類型：精簡報告

處理方式：本計畫可公開查詢

中　華　民　國 95 年 5 月 20 日

行政院國家科學委員會補助專題研究計畫 □ 成 果 報 告 ■期中進度報告

遠場下確認次波長尺度變化的方法之研發(1/2)

計畫類別：■ 個別型計畫　□ 整合型計畫
計畫編號：NSC　94-2215-E-009-036
執行期間：　2005 年 8 月 1 日至 2006 年 7 月 31 日

計畫主持人：陳志隆
共同主持人：
計畫參與人員：

成果報告類型(依經費核定清單規定繳交)：■精簡報告　□完整報告

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□涉及專利或其他智慧財產權，□一年□二年後可公開查詢

執行單位：國立交通大學光電工程學系(所)

中　華　民　國　95　年　5　月 19　日

中文摘要

本計畫已就研究課題完成了下列工作:

（1）提出利用遠場輻照度的變化，去回推物體作一維次波長尺度變化的算則，其精準度可到 1nm 的等級。其次，待測物一維次波長尺度變化及其相應的遠場繞射圖案變化間的解析關係被推導出，而可用來回推待測物的一維次波長尺度變化。

（2）提出一外加孔徑干涉儀(embedded aperture interferometry)的架構，可對任意待測孔徑寬度優化其遠場量測到的輻照度變化量值，而可提高其一維次波長尺度動態變化的測量靈敏度。

（3）提出利用未知訊號分離的手法，利用多光偵測器及外加孔徑干涉儀的架構，去回推孔徑兩個維度的次波長尺度動態變化，其精準度可到 1%。

（4）利用量測遠場輻照度回推孔徑一維次波長尺度動態變化的手法，提出了一個可量測待測物的邊緣平整度誤差低於 3%的量測架構。

英文摘要

By the project support, we have developed:

(1) An approach to retrieving 1-D subwavelength feature variation from far-field irradiance measurement precision. It was numerically verified could have precision better than 1 nm. The relations between 1-D subwavelength feature variation and corresponding far-field diffraction pattern was investigated and provides good far-field characteristics in measuring 1-D subwavelength feature variation.

(2) A tunable asymmetrically embedded-aperture interferometer configuration to enhance detection sensitivity of 1-D subwavelength variation measurement at arbitrary aperture width.

(3) A multi-detector, embedded-aperture interferometer configuration accompanies blind signal separation method to recover coupled 2-D subwavelength variation information of a rectangular aperture with far-field irradiance measurement with error ratio below 1%.

(4) By using the approach to retrieve 1-D subwavelength variation from far-field irradiance measurement, a constructed-aperture measurement system behaving as an optical ruler was proposed could measure the marginal roughness of the test sample with error ratio below 3%.

關鍵詞(keywords)

Interferometry, interferometer, far-field irradiance, subwavelength measurement, diffraction theory

I. 前言/研究目的/文獻探討

Since we have published several long papers in which the motivation and the historical development have been detailed. We skip the corresponding paragraphs here. It is recommended to reference our publications.

II 研究方法

We mainly employed the classical diffraction theory to investigate a variety of configurations and look for the means that can improve the detection and measurement. Extended diffraction theory that includes vector diffraction theory is also on the way of development.

III. 結果與討論（含結論與建議）

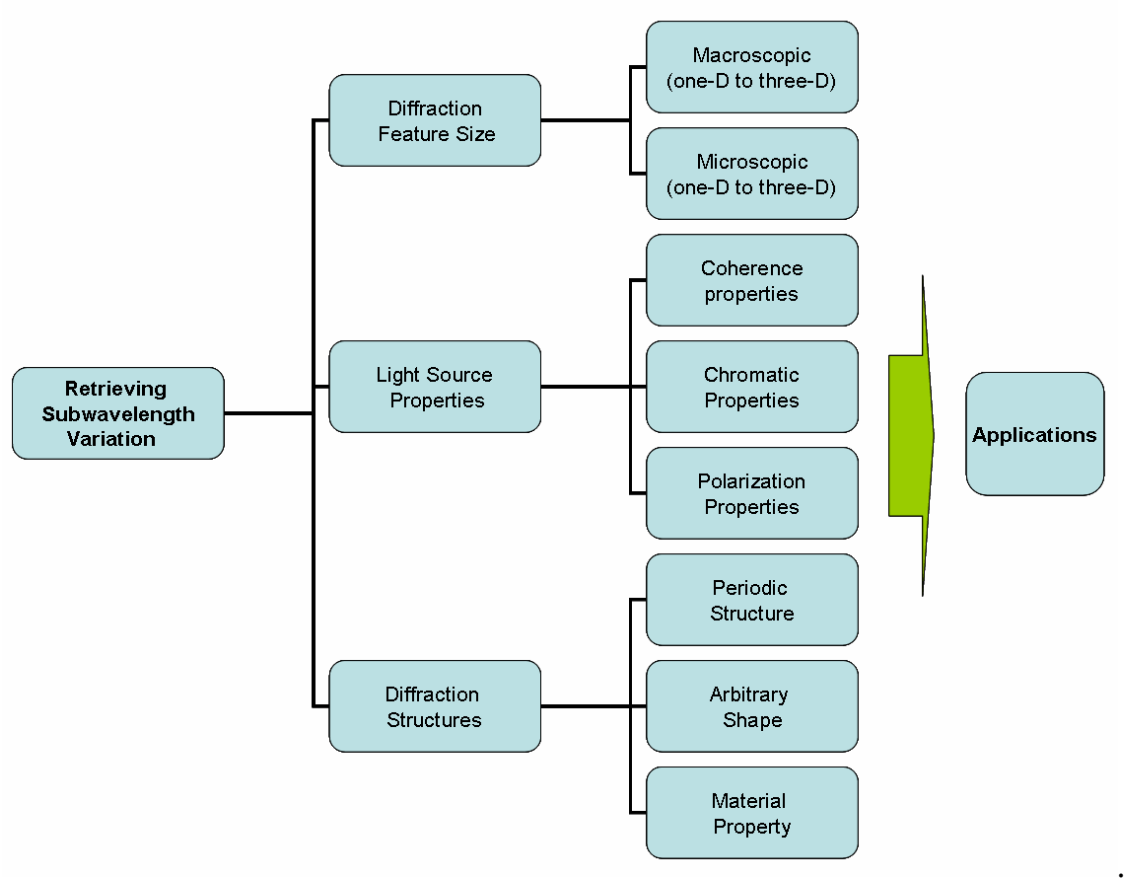
As a summary of the current status of our study, we have developed several approaches to retrieving dynamic signature of 1-D subwavelength-scale variation, to enhance 1-D subwavelength variation measurement intensity, and to decouple 2-D subwavelength variation with far-field optical measurement. Furthermore, an extension application to identify the spatial marginal roughness in the precision of subwavelength scale from only far-field irradiance measurement has also been proposed.

We thank the NSC for the supports in these years.

IV. 計畫成果自評部份

Retrieving subwavelength information is an extensive and important topic and thus has been widely investigated. Several near-field measurements have been proposed to retrieve the subwavelength feature detail of specimen while specimen size was in mesoscopic or nanoscopic region. While the retrieving of dynamic signature of subwavelength variation yields some more interesting information than the static features, particularly in determining physical origins and in identifying the generation mechanism, e.g., thermal characteristic, vibration, deformation. Thus, to retrieve subwavelength-scale dynamically variation is another important issue should be worthwhile to further investigate. We believe that we have achieved some progresses in this field.

However, as the roadmap of investigation we have figured out recently that shown below, there remains a lot of works for further investigation



V. 論文發表

目前相關論文發表如下

5. Characterization of one-dimension marginal roughness from far-field irradiance at subwavelength scale precision, **J. of Optical Society of America** (JOSA) A **(submitted; in revision)**, S.-C. Chu and J.-L. Chern
4. Retrieving two-dimensional information of the subwavelength variation from far-field irradiance, **J. of Optical Society of America (JOSA) A,** (2006) (accepted), S.-C. Chu and J.-L. Chern
3. Identifying the subwavelength aperture-width variation in the far field with tunable asymmetrically-embedded-aperture interferometer configuration, **J. of Optical Society of America (JOSA) A**, 22, 1600-1606 (2005) S.-C. Chu and J.-L. Chern
2. Detection of Subwavelength Slit-width Variation with Measurements in the Far Field using an Embedded-aperture Interferometer configuration, **J. of Optical Society of America (JOSA) *A***, **22**, 335-341 (2005) S.-C. Chu and J.-L. Chern
1. Characterization of the Subwavelength Variation Signature from Far-field Irradiance," **Opt. Lett.** 29, 1045-1047 (2004) S.C. Chu and J.-L. Chern