Novel Application of Diffractive Optical Elements in Optical Systems

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Novel Application of Diffractive Optical Elements in Optical Systems
新型衍射光學元件在光學系統上的應用

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Abstract

Dammann proposed the special type of diffraction grating which is periodic in nature together with binary phase for achieving high splitting ratio. Later, researchers proposed different kinds of methods for improving the performances. Dammann Gratings can be used in many areas, and in this project, we aim to expand the potential applications of employing Dammann Grating, specifically in the areas of optical communications and optical measurements.

Firstly, Fiber-to-the-Home (FTTH) is a residential communication system in which fiber goes though the user's home. FTTH can provide much more bandwidth than Asymmetric Digital Subscriber Line (ADSL) which is one of the existing common broadband technologies. In addition, this network has the ability to provide all-round services and to become more feasible. Dammann Grating is then one of the suitable candidates in optical fiber communication. The proposed scheme using Diffractive Optical Elements (DOE) will have great potential for fiber-to-home network when compared with other techniques such as fused fiber couplers, waveguide splitter and micro electro-mechanical systems (MEMS) which are all affected by high PDL and uniformity loss. In this project, we will discuss the optical beam splitter performance

in both 1D and 2D packaged silica and POF fiber arrays.

Secondly, the Circular Dammann Grating (CDG) is a diffraction grating which produces circular beams in ring-shape at the image plane. Zhou, Zhao and Chung proposed different techniques. However, there are pros and cons. In this thesis, we present and analyze other novel approaches based on the concept of circular rotation, Hankel transform and non-zero order binary annulus mask of the nth order diffraction spots to achieve the same objectives as mentioned above with better results.

We have explored the feasibility study of employing CDG for measuring the angle of an object. Both theoretical and experimental results show that it agrees well with the calculation. Through the Charged Coupled Device (CCD) camera, the diameter of the major axis in tilted CDG can be measured. The accuracy is governed by the focal length of converging lens and the period of grating. Generally speaking, this design could be applied in micro-systems with the benefit of easy and robust configuration.

To conclude, we demonstrated the feasibility studies of applying Dammann Grating into PON splitter and optical measurement both theoretically and experimentally. We believe that this grating could be widely contributed in many areas.

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Abbreviations

ADSL	Asymmetric Digital Subscriber Line
AMIRE	Angle Measurement based on Internal Reflection Effect
BKK	Burckhardt, Kaspar and Knop
CCD	Charged Coupled Devices
CDG	Circular Dammann Grating
CVD	Chemical Vapor Deposition
DFB	Distributed Feed-Back
DOE	Diffractive Optical Elements
DSL	Digital Subscriber Line
DWDM	Dense Wavelength Division Multiplexing
EDFA	Erbium Doped Fiber Amplifier
FHD	Hydrolysis Deposition
FTTH	Fiber To The Home
HDTV	High Definition TV
IFTA	Iterative Fourier Transform Algorithm
MAN	Metropolitan Area Network
MEMS	Micro-Electro-Mechanical Systems
OPD	Optical Path Difference
P2P	Point to Point
PDL	Polarization Dependent Loss
PLC	Planar Lightwave Circuit
POF	Polymer Optical Fiber

PON	Passive Optical Network
RIE	Reactive Ion Etching
SA	Simulated Annealing
WDM	Wavelength Division Multiplexing