

# Novel Application of Diffractive Optical Elements in Optical Systems

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Novel Application of  
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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 through 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  $n$ th 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

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

<b>PON</b>	Passive Optical Network
<b>RIE</b>	Reactive Ion Etching
<b>SA</b>	Simulated Annealing
<b>WDM</b>	Wavelength Division Multiplexing