Manufacturing Computer-generated Holography and Diffractive Optical Element with Nanoscribe 3D Nanoprinter

MICRO-373
Project Introduction

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Project: CGH/DOE Manufacturing with Nanoscribe

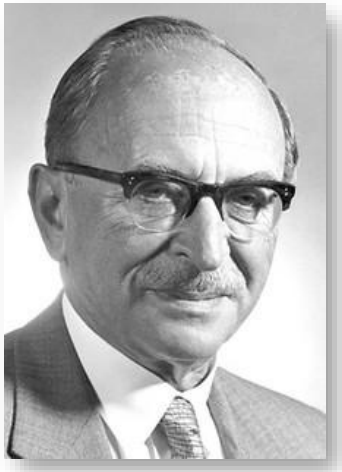
Goal

- Learn the manufacturing of a high-resolution CGH

Objective

- Understand the principle of holography
- Understand how CGH/DOE works
- Understand Fourier transform in optics
- Practice CGH/DOE with Gerchberg–Saxton algorithm
- Practice CGH/DOE manufacturing with Nanoscribe

Holography: the Beginning



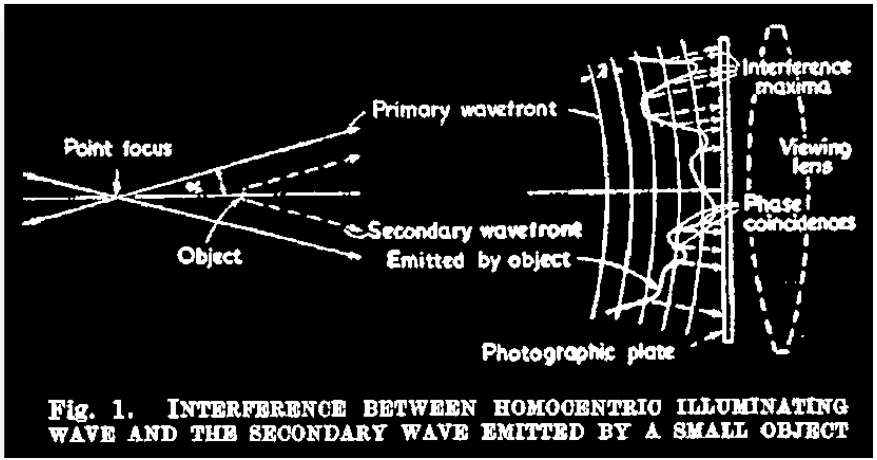
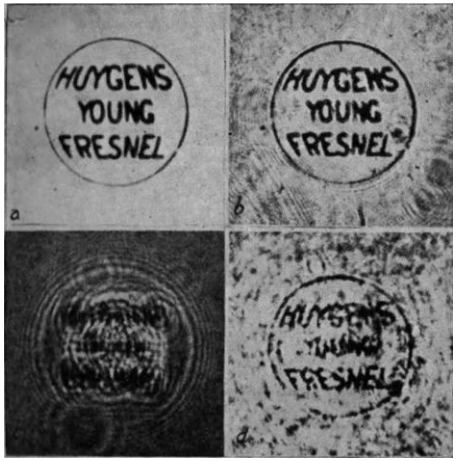


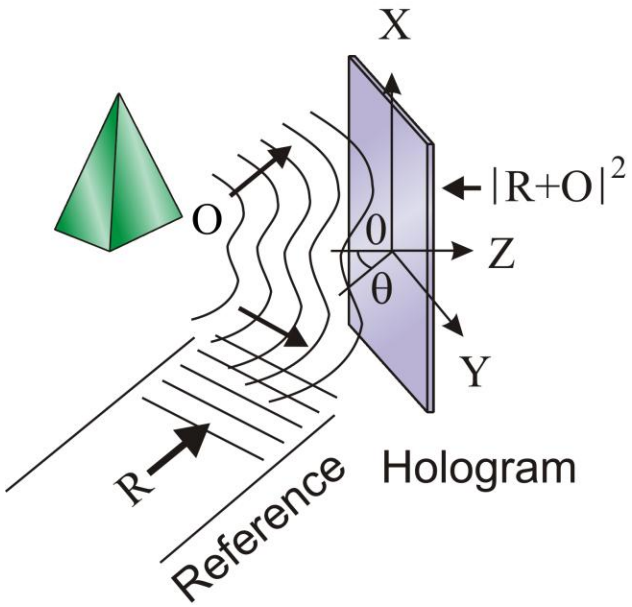
Fig. 1. INTERFERENCE BETWEEN HOMOCENTRIC ILLUMINATING WAVE AND THE SECONDARY WAVE EMITTED BY A SMALL OBJECT

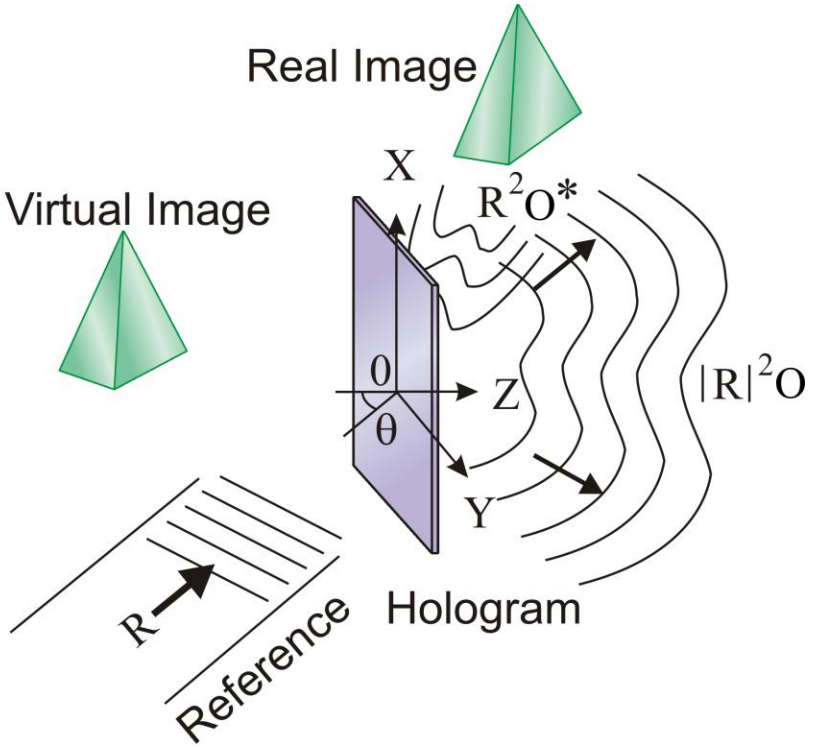


D. Gabor, “A new microscopic principle”, Nature **161**, 777–778 (1948)

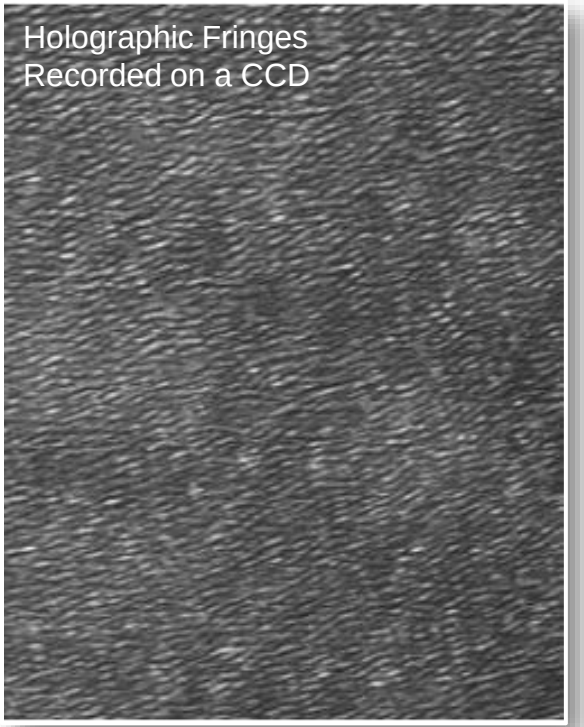
- Invented in 1948 by Dennis Gabor to correct aberrations in electron microscope
- Optical holography only possible after invention of laser
- Special interferometry records and recovers full wave front
- Capable of 3D imaging

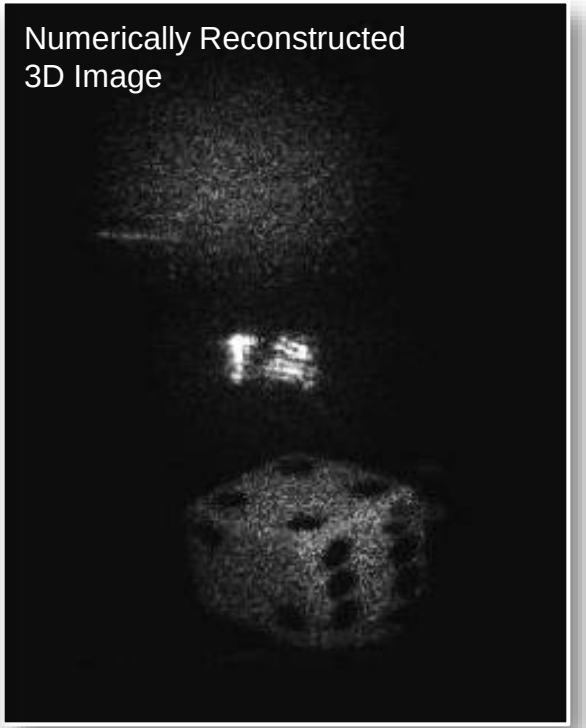
Principle of Holography





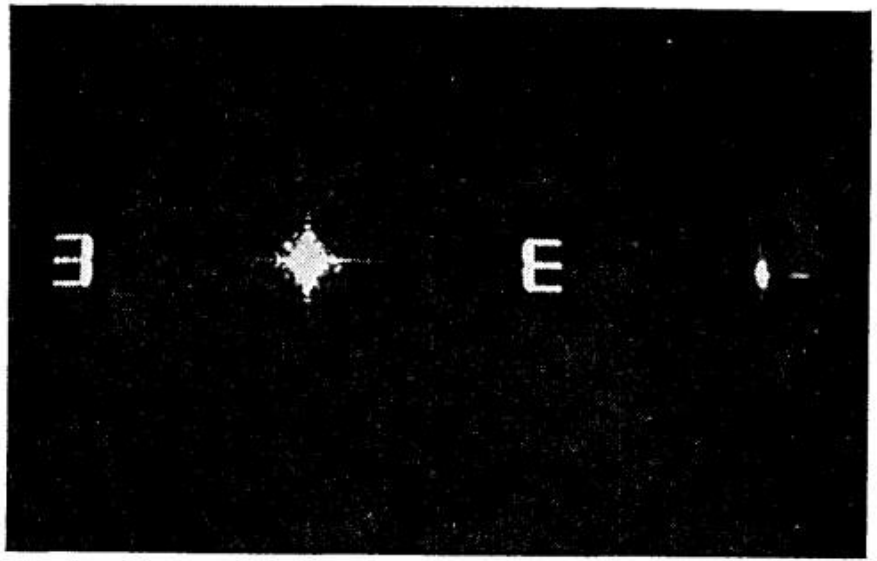
Digital Holographic Recording





- Concepted in 1967
- Term established in 1971
- Demonstrated with a CCD in 1994
- Digital advantages
  - No chemical process
  - Real-time
  - Highly sensitive
  - Quantitative phase-retrieval
  - Flexible algorithms

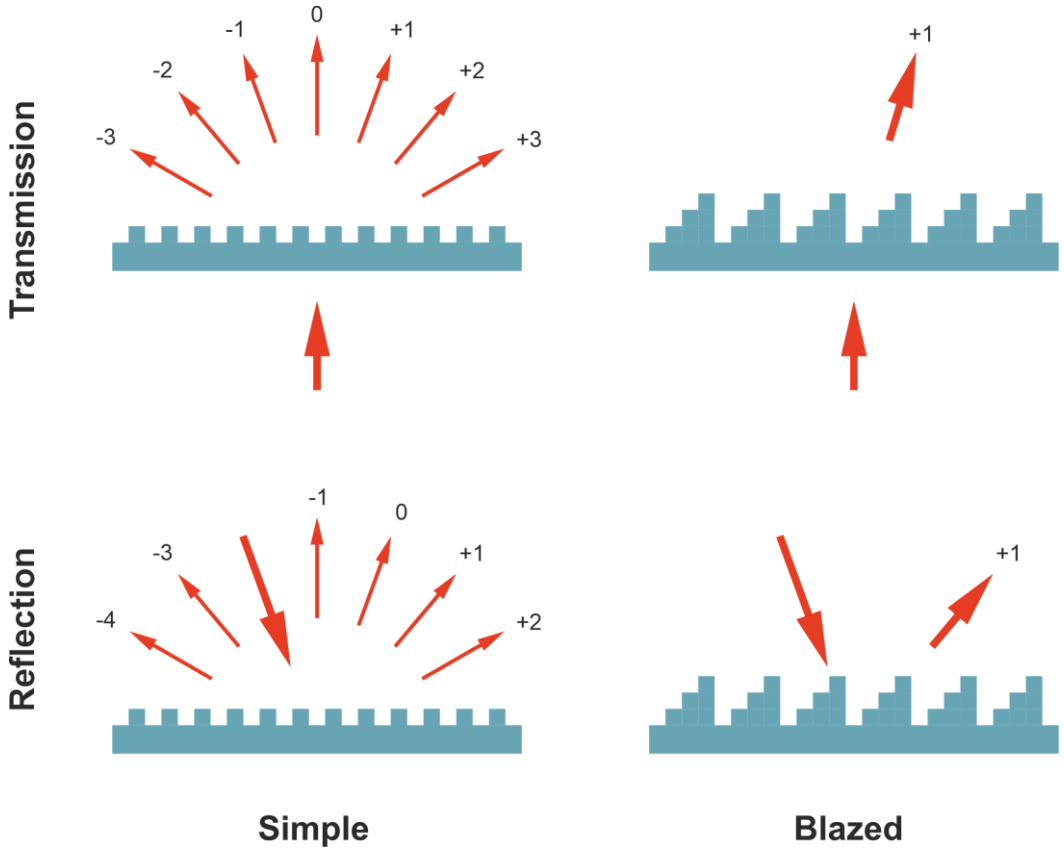
Computer-generated Hologram



B. R. Brown and A. W. Lohmann, “Complex Spatial Filtering with Binary Masks”, Appl. Opt. **5**, 967–969 (1966)

- Demonstrated in 1966
- First digital wave front synthesis
- Uses hand-drown and binary spatial filters
- Requires excessive computing power of the time
- Primary Tool: Gerchberg–Saxton algorithm
- Dynamic version possible only with SLM

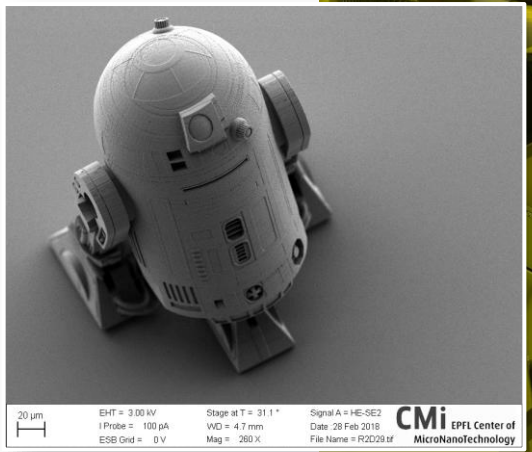
Diffractive Optical Elements

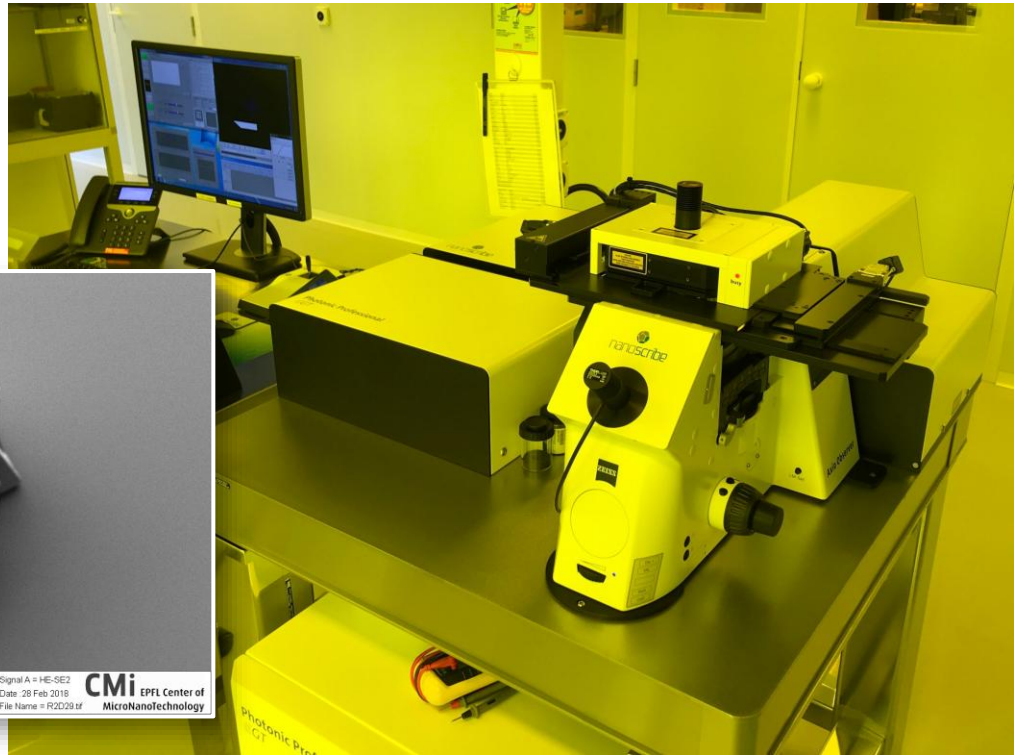


CGH and DOE in Daily Life

The Nanoscribe 3D Nanoprinter

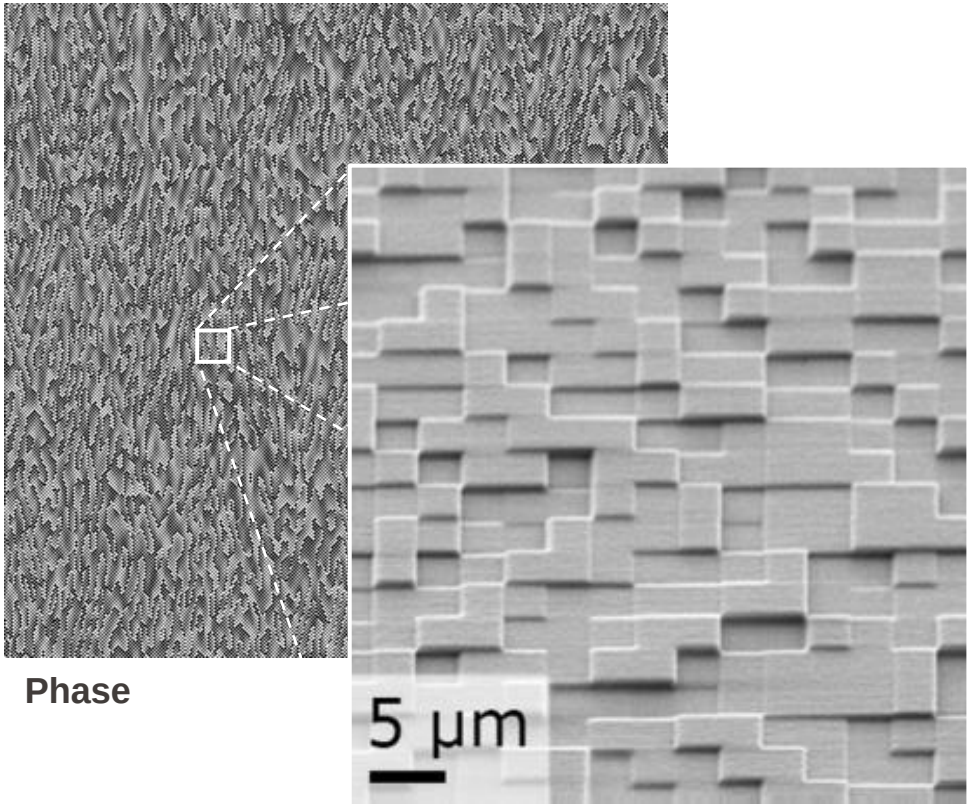
- Nanoscribe Photonic Professional GT+
- Two-photon polymerization
- Max. resolutions:
  - X-Y: 200 nm
  - Z: 700 nm





Hologram with Nanoscribe 3D Nanoprinted

Target



Phase

Thank You!