Advanced Gratings

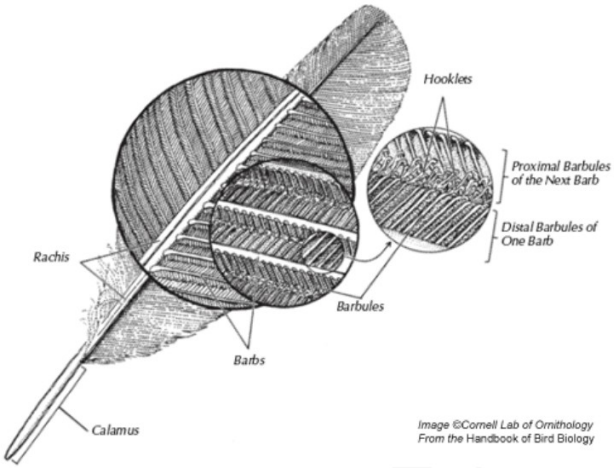
Andrea Bianco
INAF – Osservatorio Astronomico di Brera

KNOWLEDGE EXCHANGE
Between Industry and Astronomy
Wednesday 29 Juna 2016, Edinburgh

Dispersing elements for astronomy

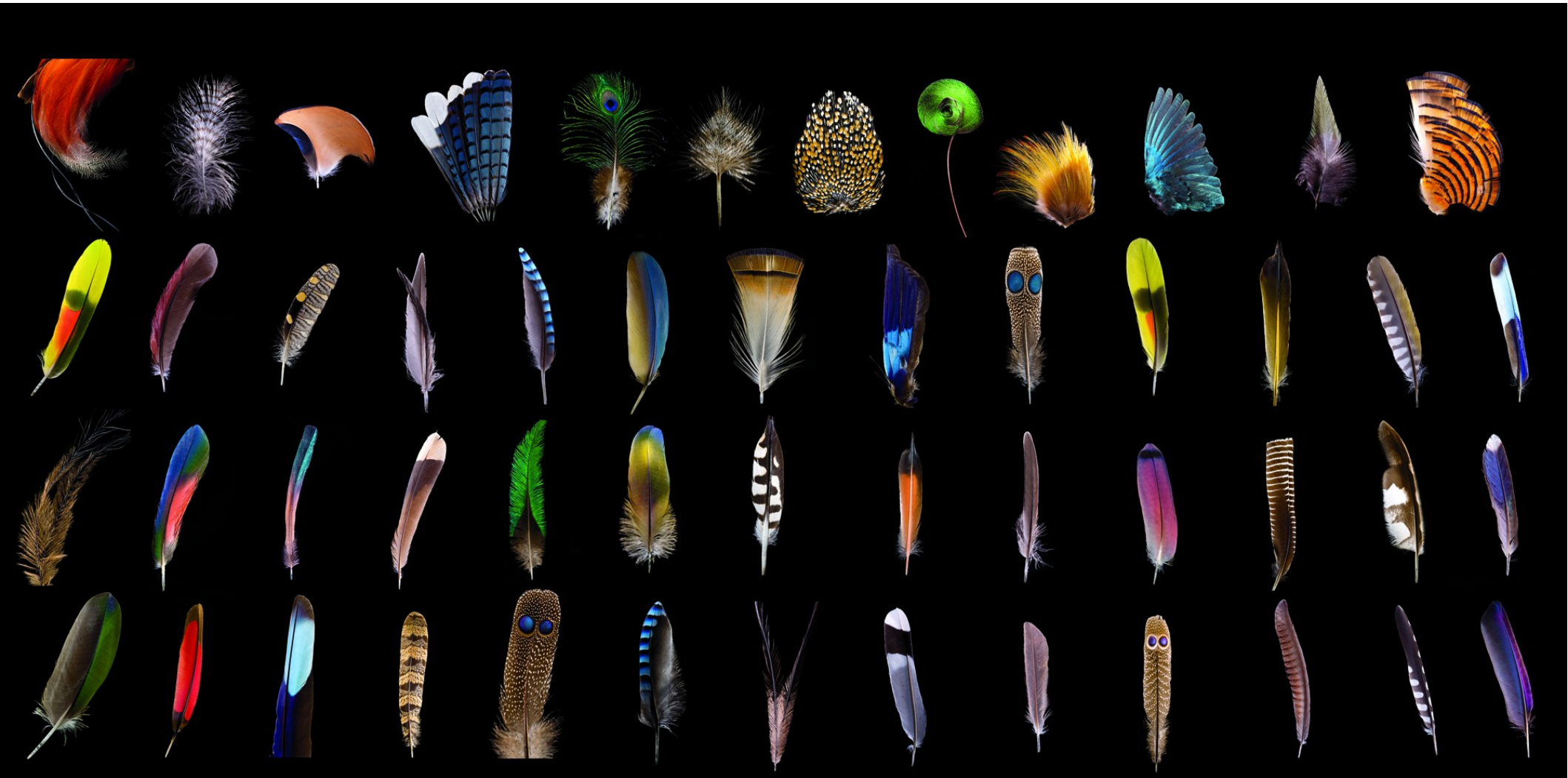
The diffraction grating in the mid of 17th century...

thanks to James Gregory



Dispersing elements for astronomy

Different sizes and different dispersing properties...

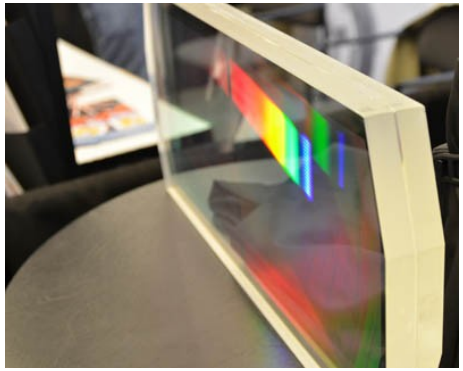


Photograph by Robert Clark

Dispersing elements for astronomy

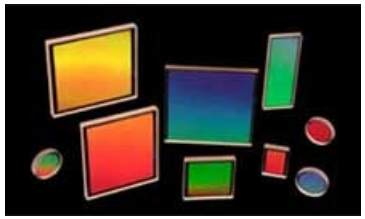
The situation in 2016...

Volume Phase Holographic Gratings (VPHGs)



Credits: KOSI

Credits: Emilio



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Technology brought from
Raman instruments

Dispersing elements for astronomy

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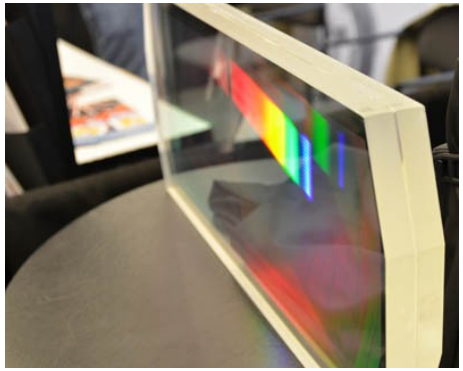

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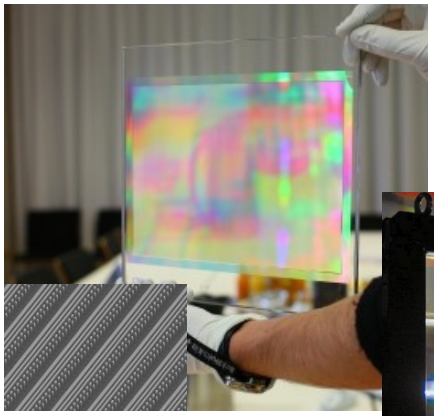
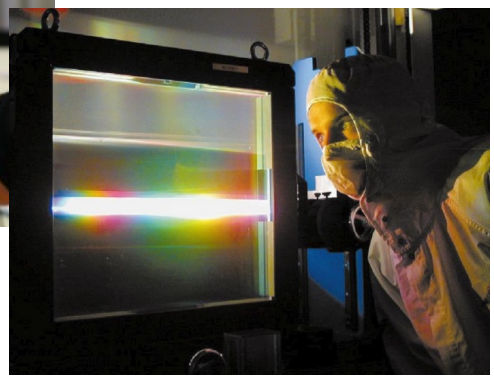
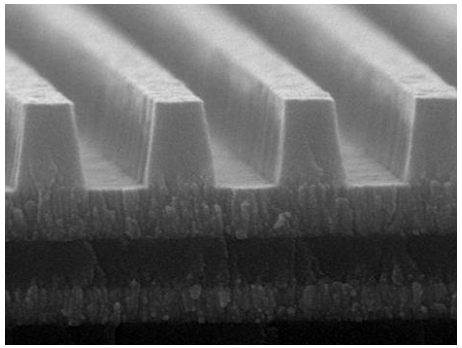
Lithographic Gratings



Credits: Nasa and IOF



Credits: Horiba



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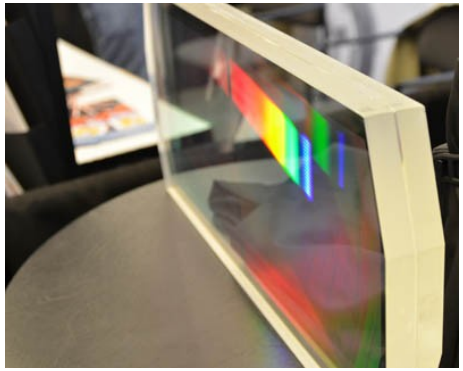

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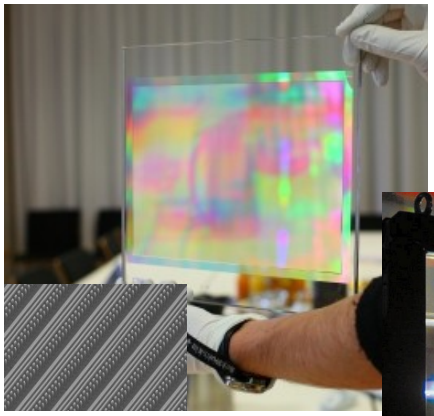

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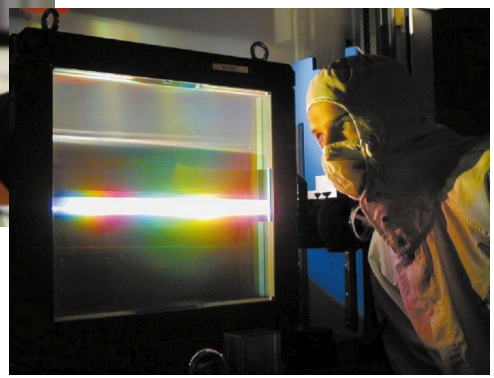

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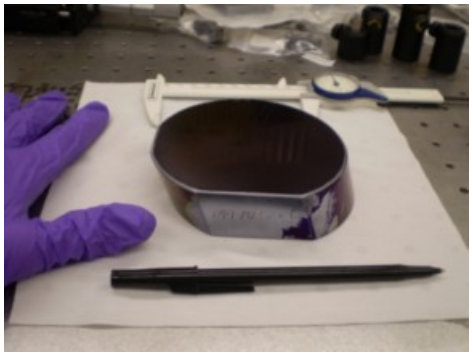
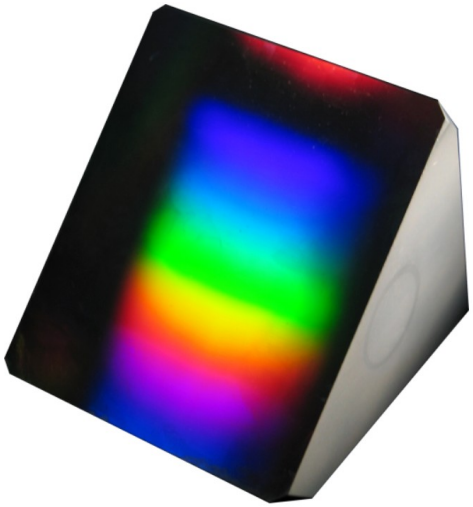
Immersed grating, Si, ZnSe grism



Credits: UTexas



Credits: SRON

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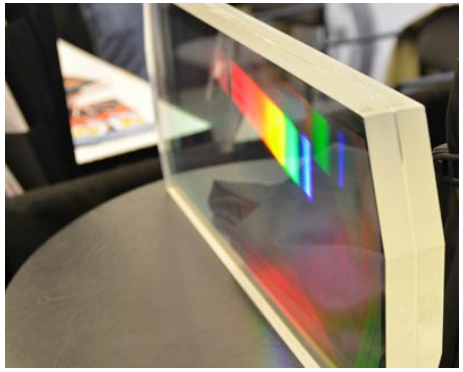

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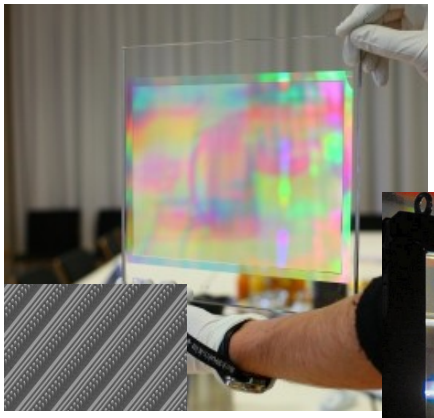
Lithographic Gratings



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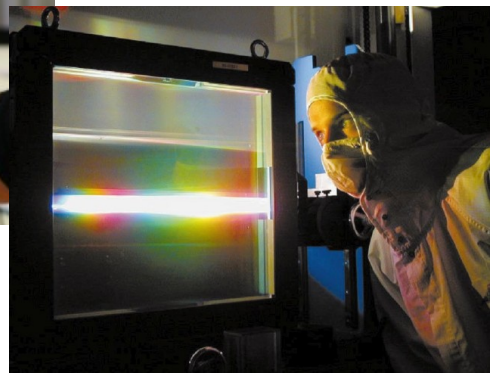

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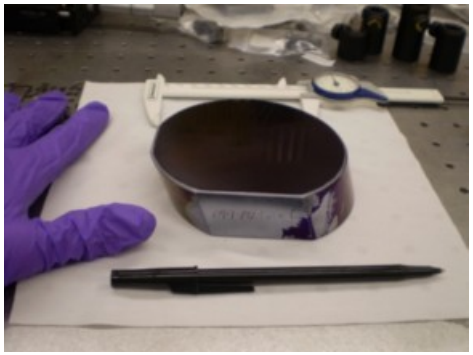

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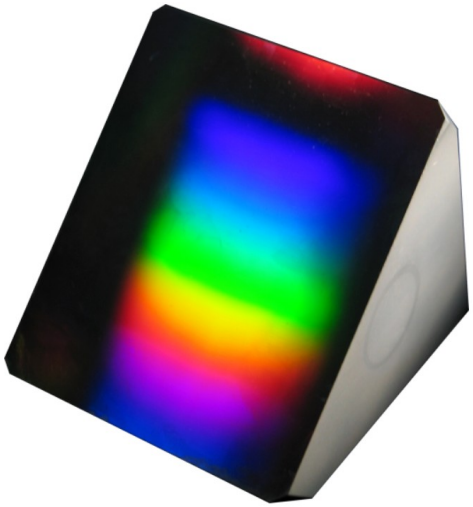

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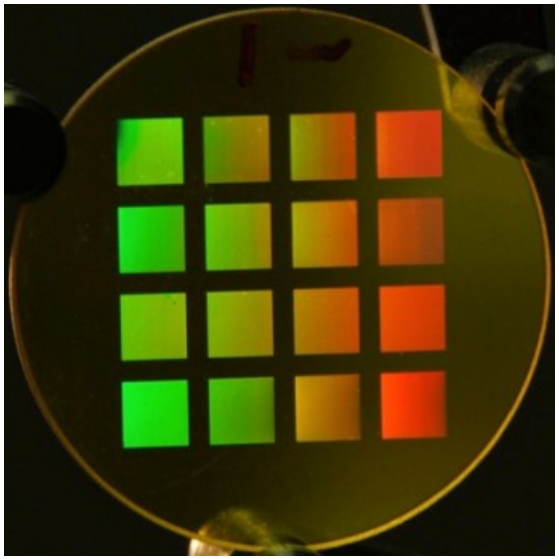
ULI gratings



Credits: STFC - UK

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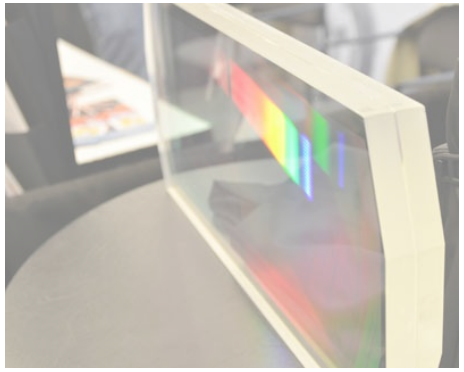

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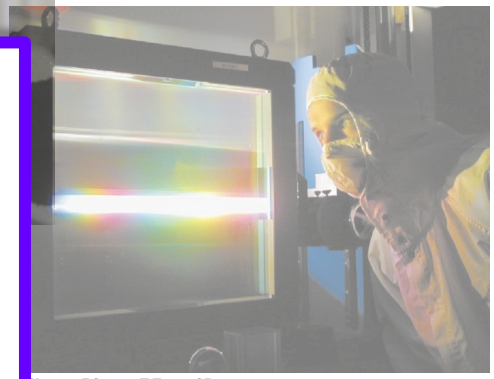
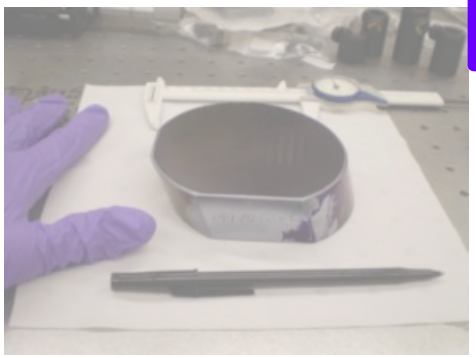


Credits: Horiba

There are different approaches for making dispersing elements for astronomy.

Depending on the spectral range, dispersion, resolution, size it is important to choose the best technology.

Immersed grating, Si, ZnSe grism



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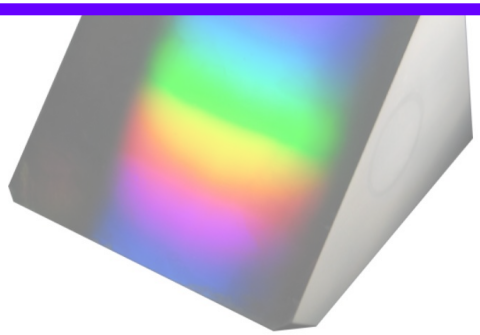

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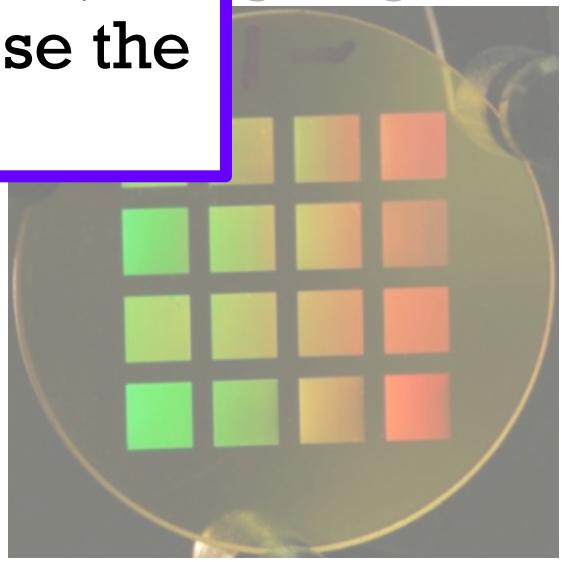
gratings



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Volume Phase Holographic Gratings

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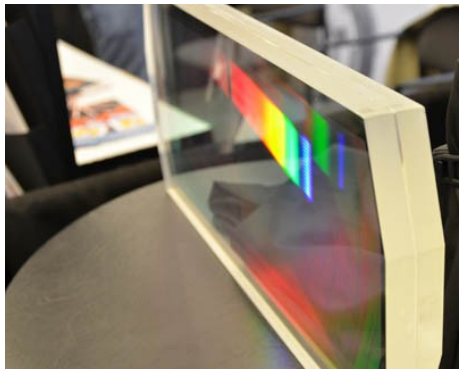

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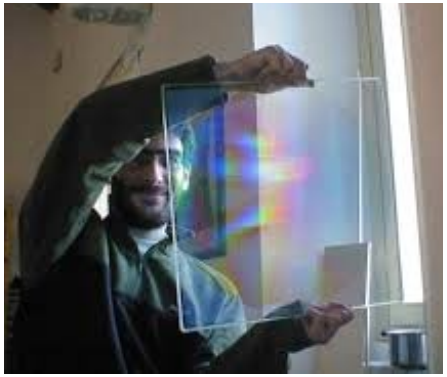
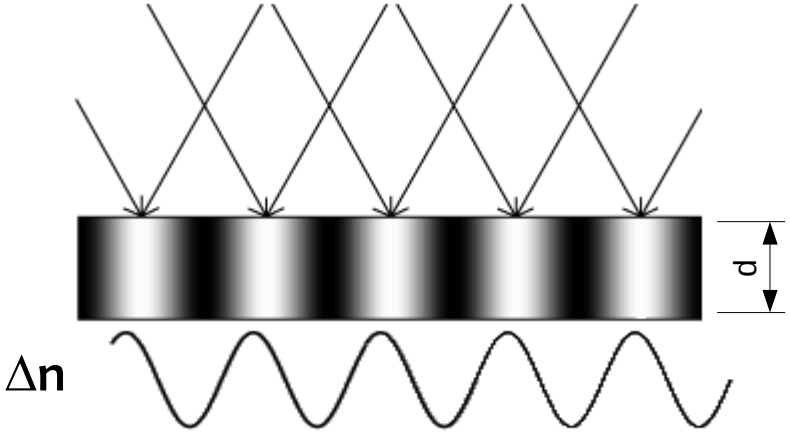
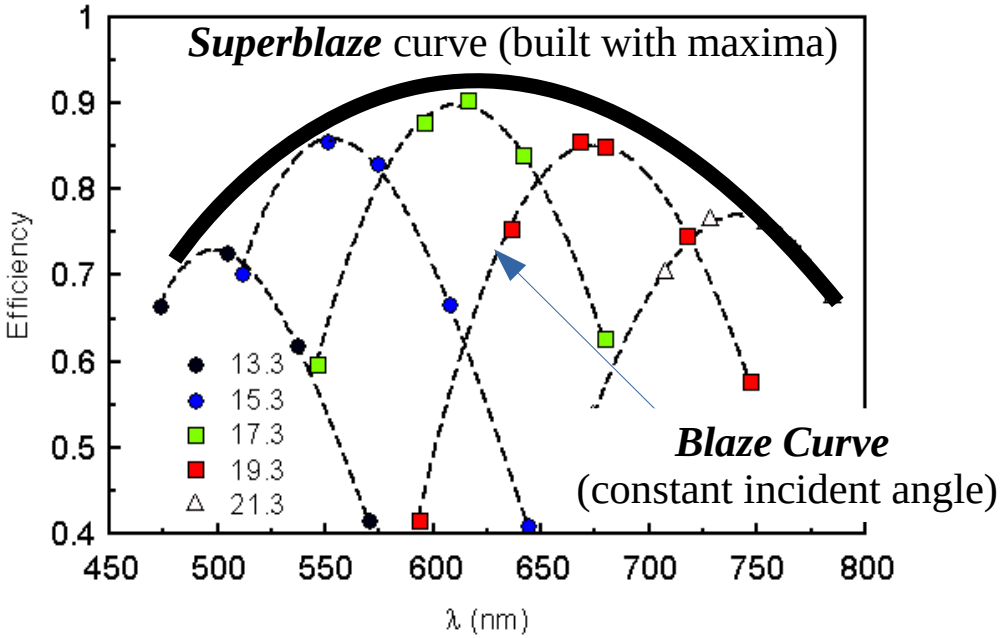


Credits: Emilio



Diffraction due to a periodic refractive index modulation



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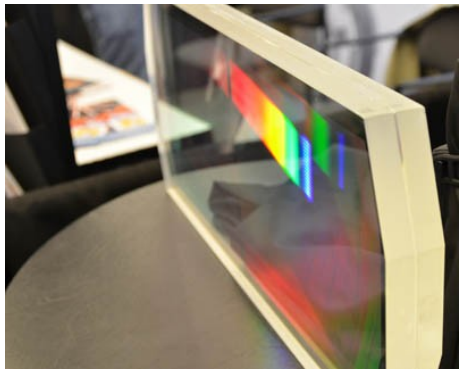

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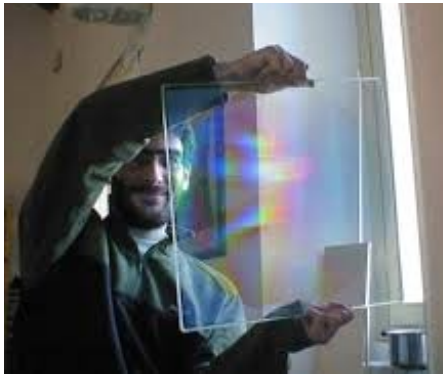

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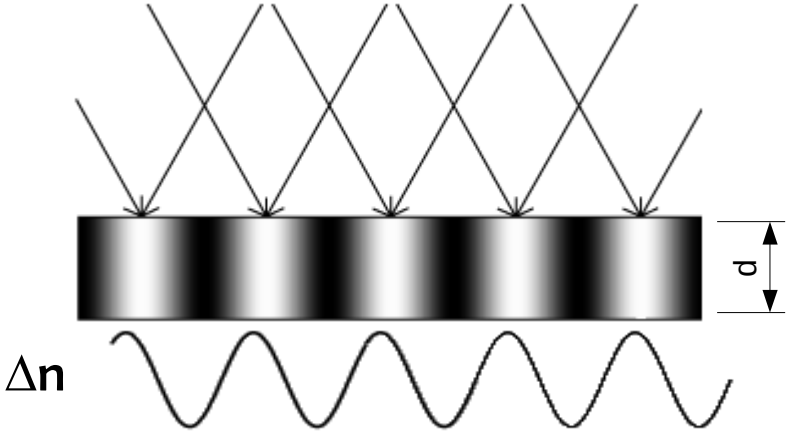
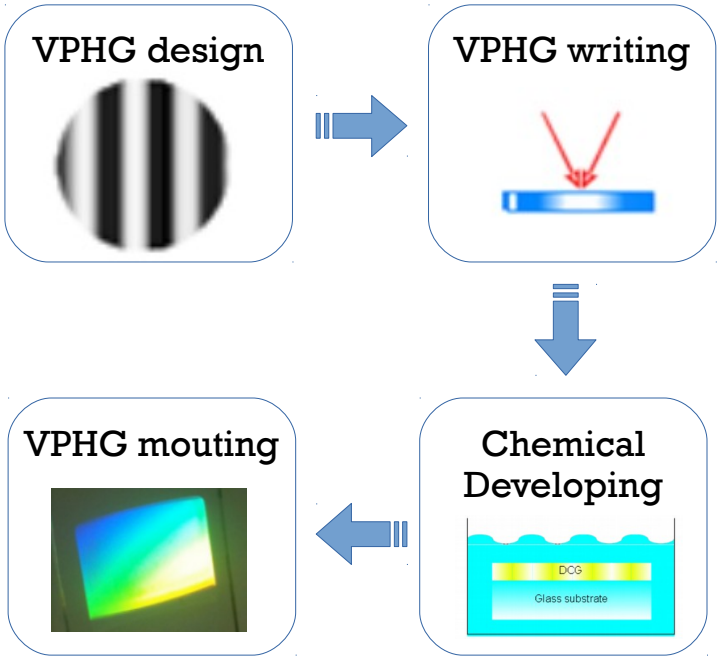
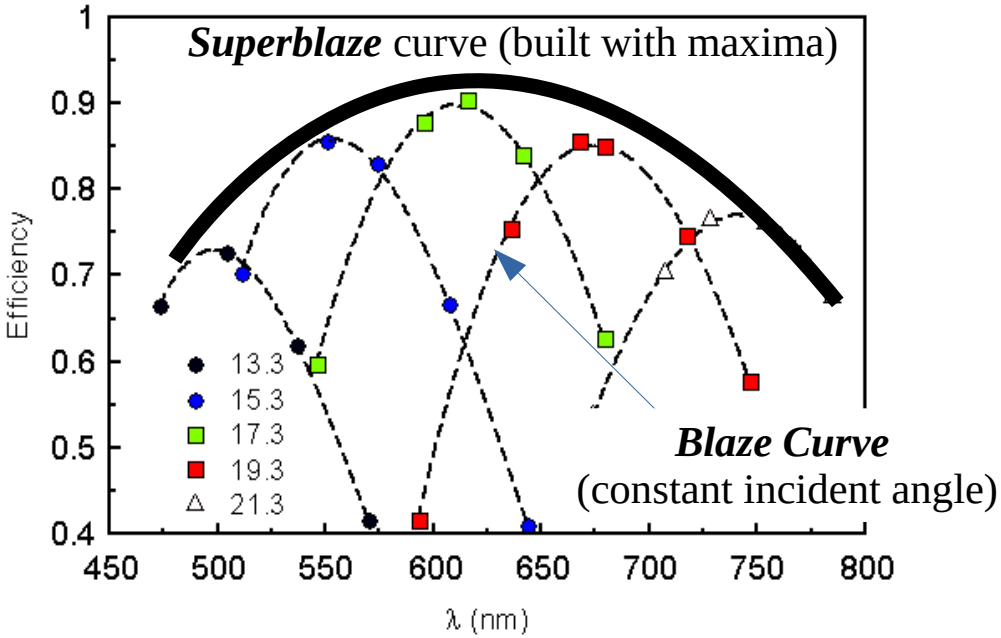


Diffraction due to a periodic refractive index modulation

Dichromated Gelatin process





Volume Phase Holographic Gratings

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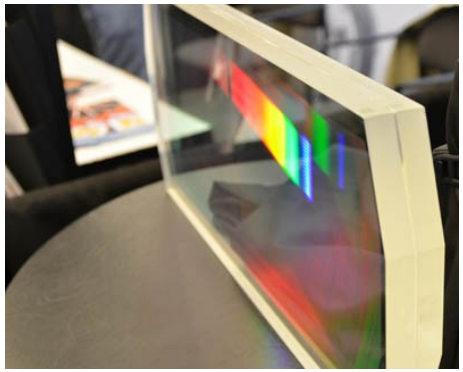

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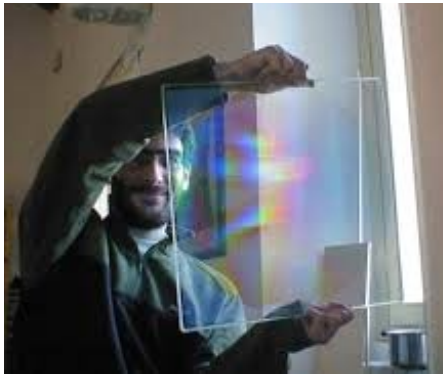

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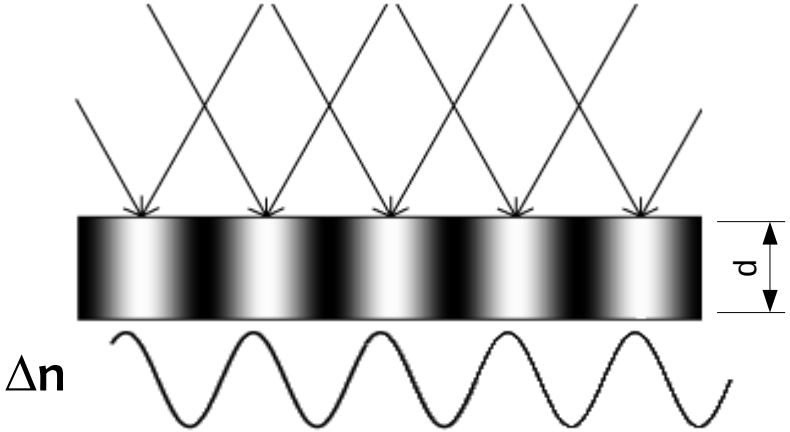

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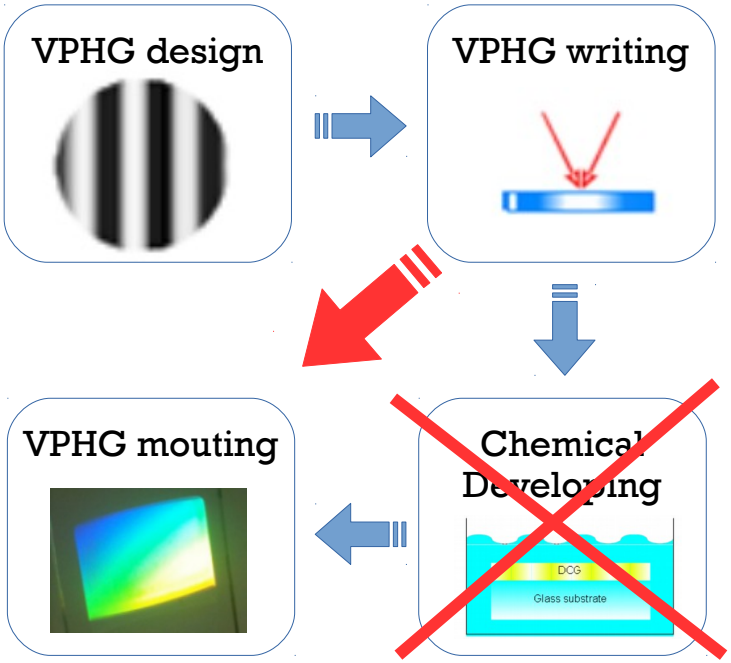
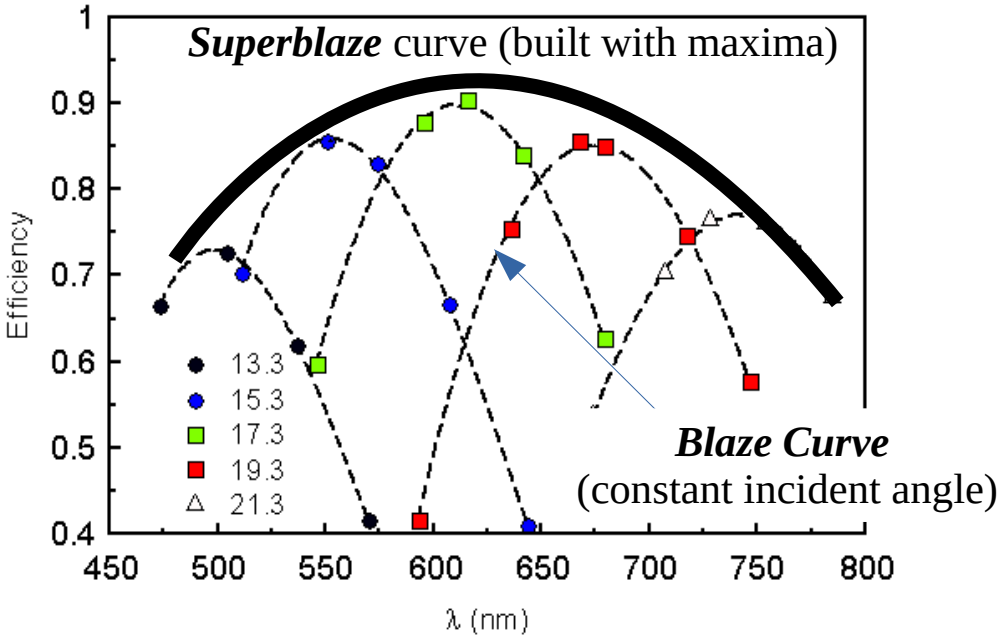


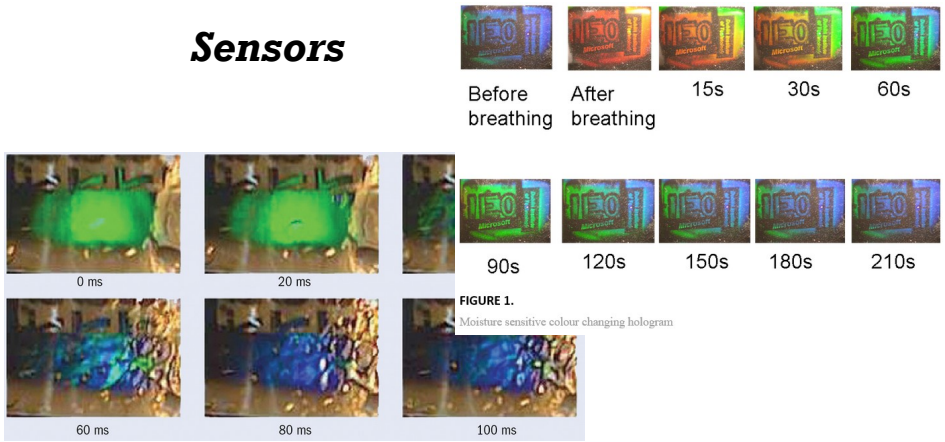


Looking for new materials…
Applications of volume holography

Security and authentication

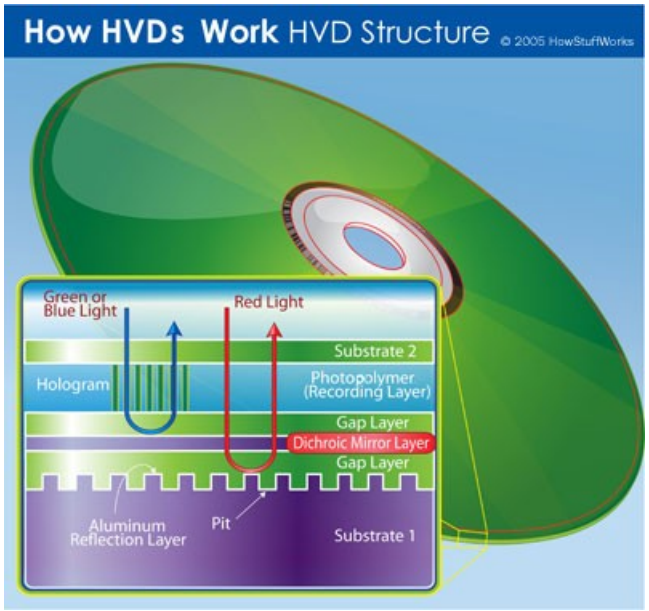
February 2008 issue of Physics World

Sensors

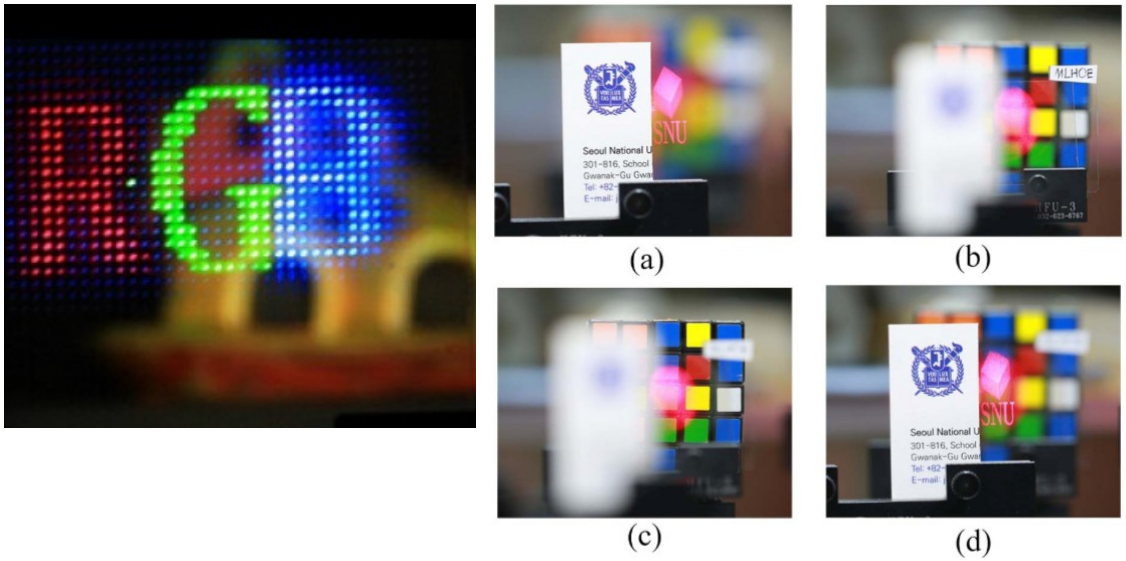


"Holography - Basic Principles and Contemporary Applications" edited by Emilia Mihaylova

3D holographic memories



Display for augmented reality



Optics Letters, 41, 11 (2016)

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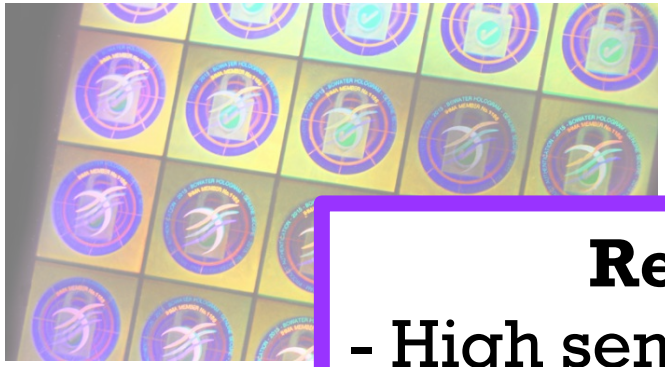

February 2008 issu

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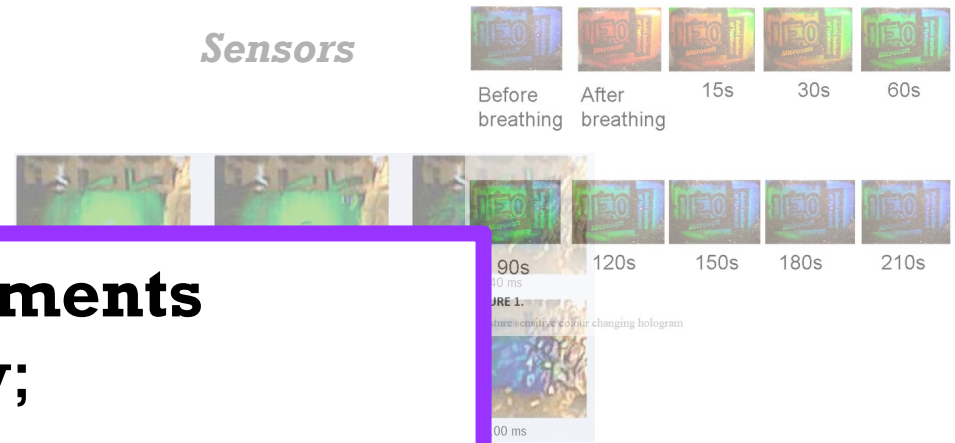

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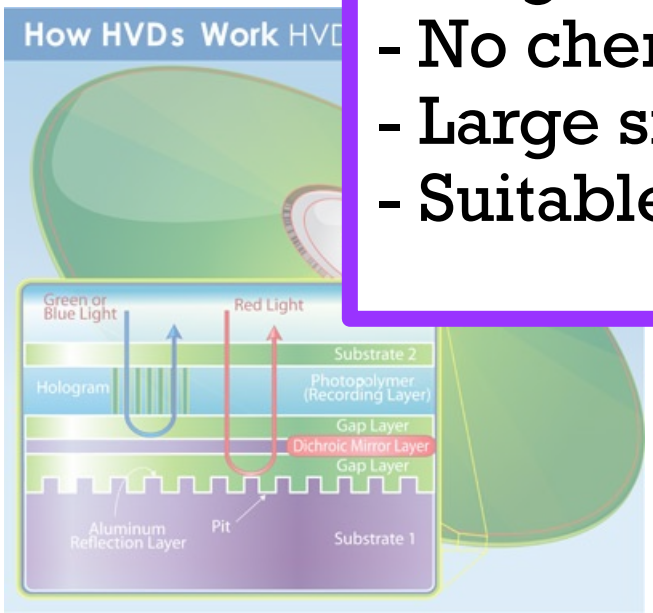
3D holographi



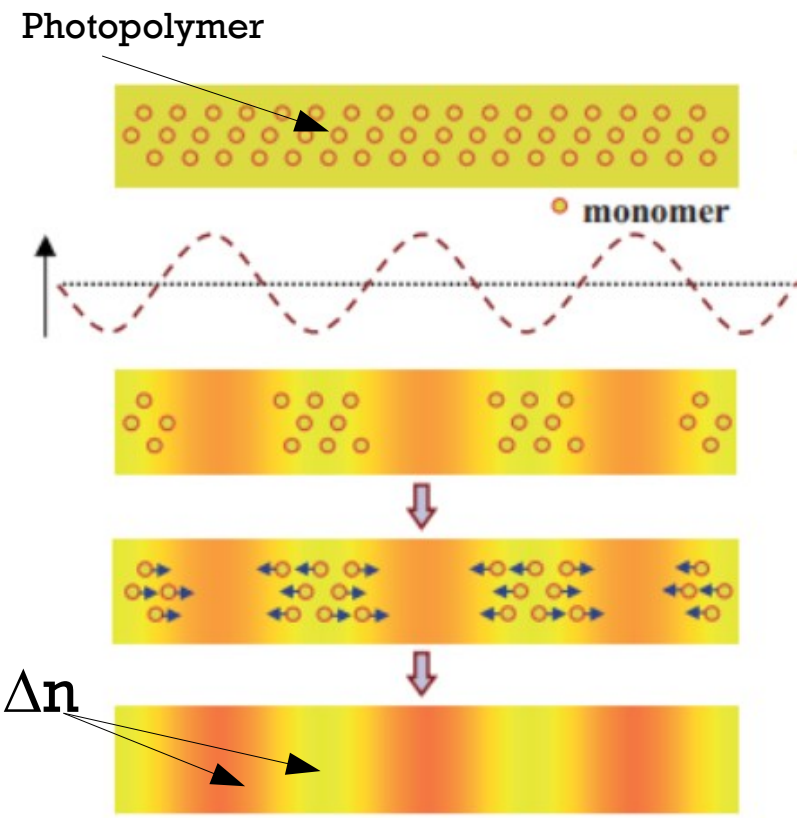
Requirements

- High sensitivity;
- Low shrinkage;
- Large range of thicknesses;
- No chemical process;
- Large size;
- Suitable for mass production.

ugmented reality

Optics Letters, 41, 11 (2016)

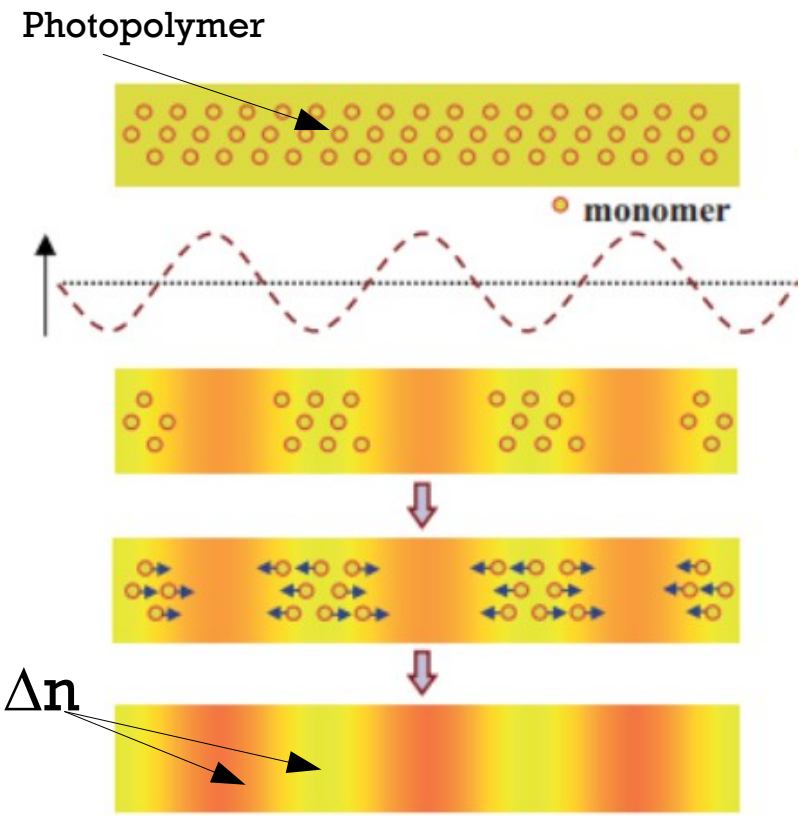
Photopolymers



Fixation

Self-developing material:
The hologram is ready to be used just after a fixation process with white light.

Photopolymers



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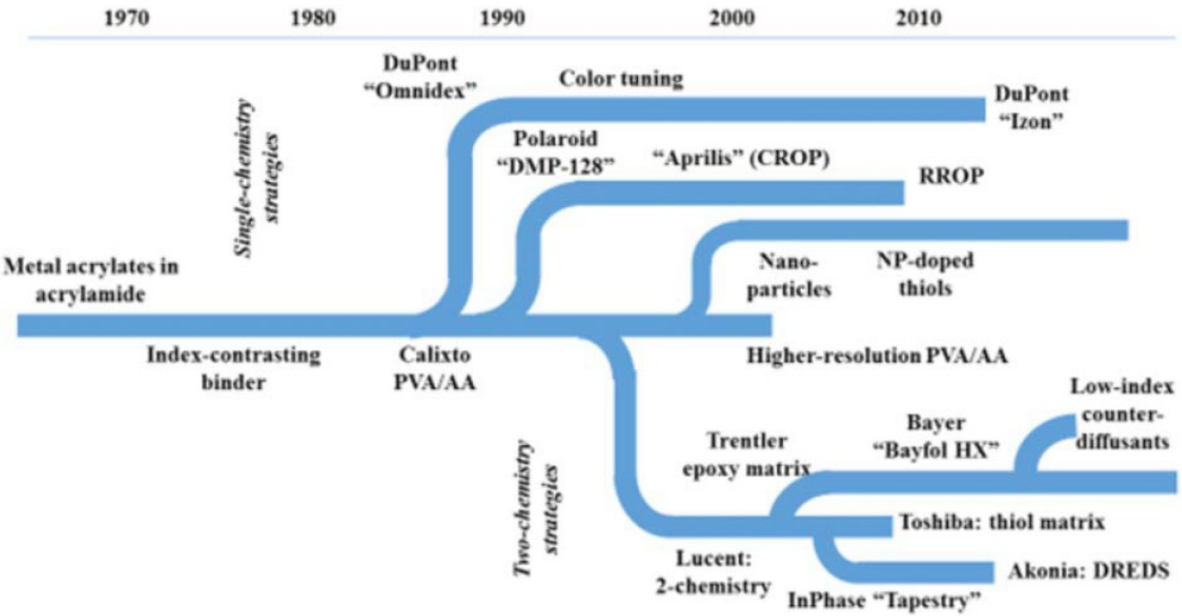
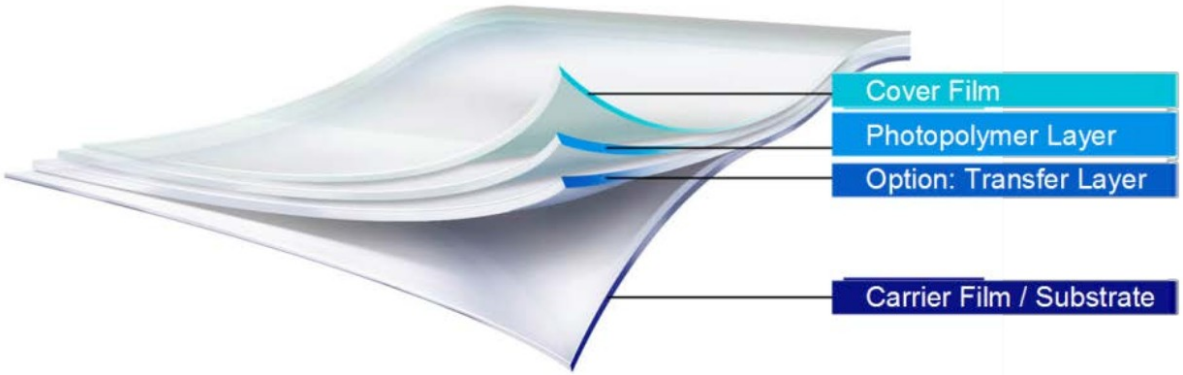
The evolution of photopolymers



JOURNAL OF POLYMER SCIENCE, PART B, 2016, 54, 1021–1035

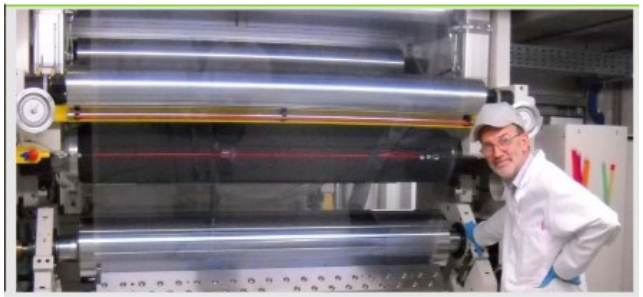
Bayfol® HX Photopolymers

Simple structure



http://www.bayer.com/en/bruder.pdfx

Very large size



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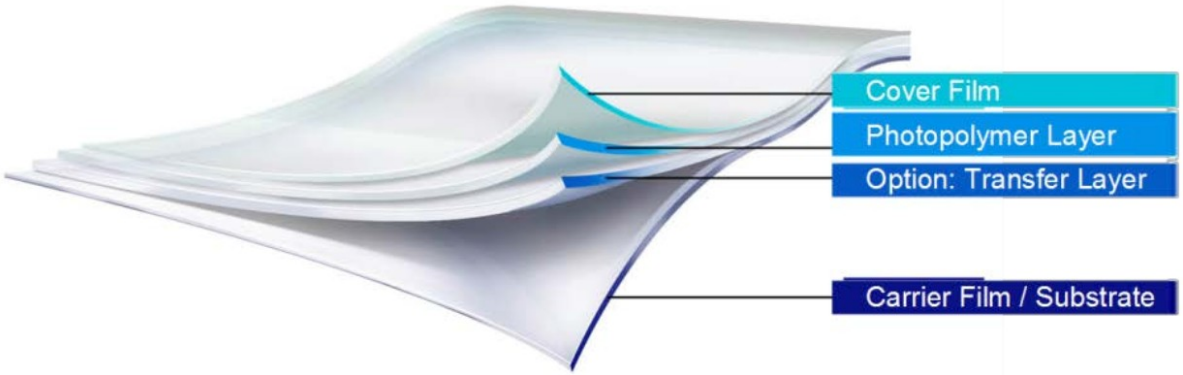

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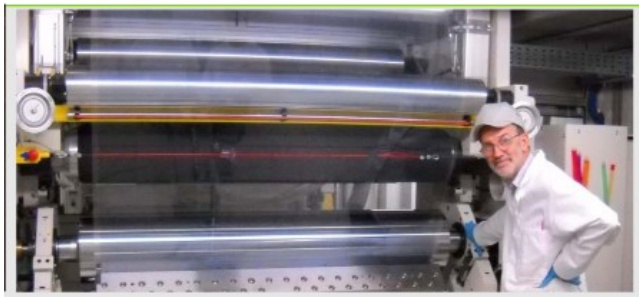
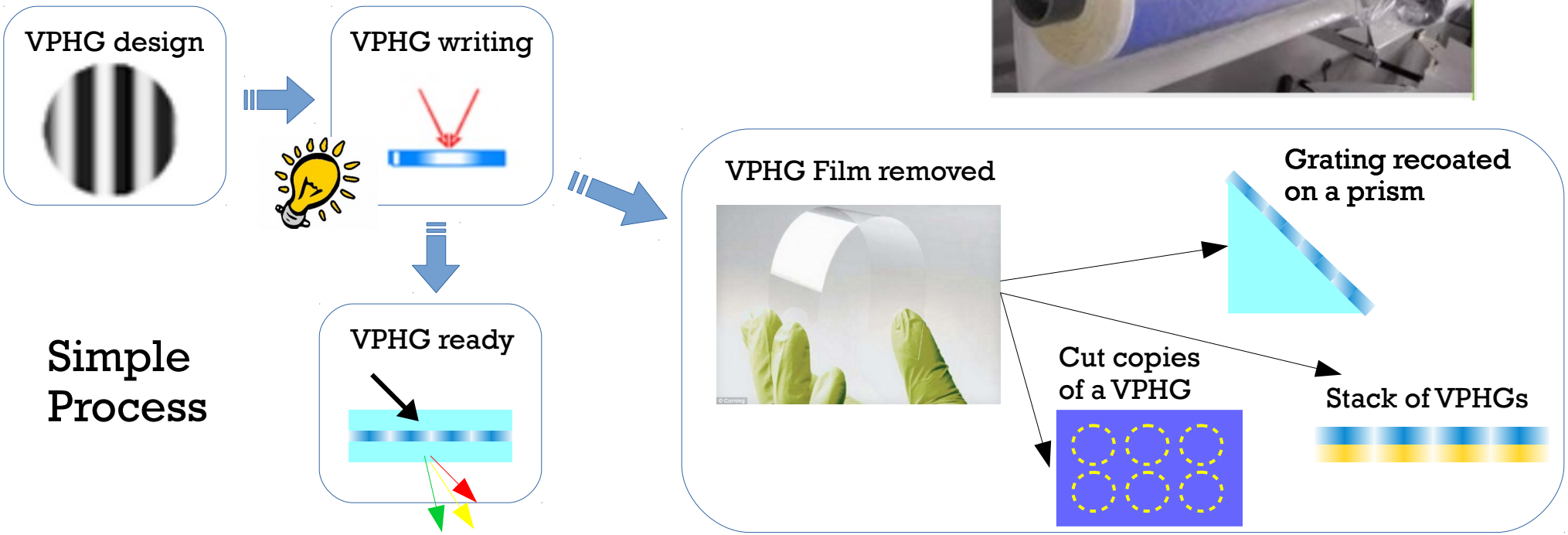


Simple Process



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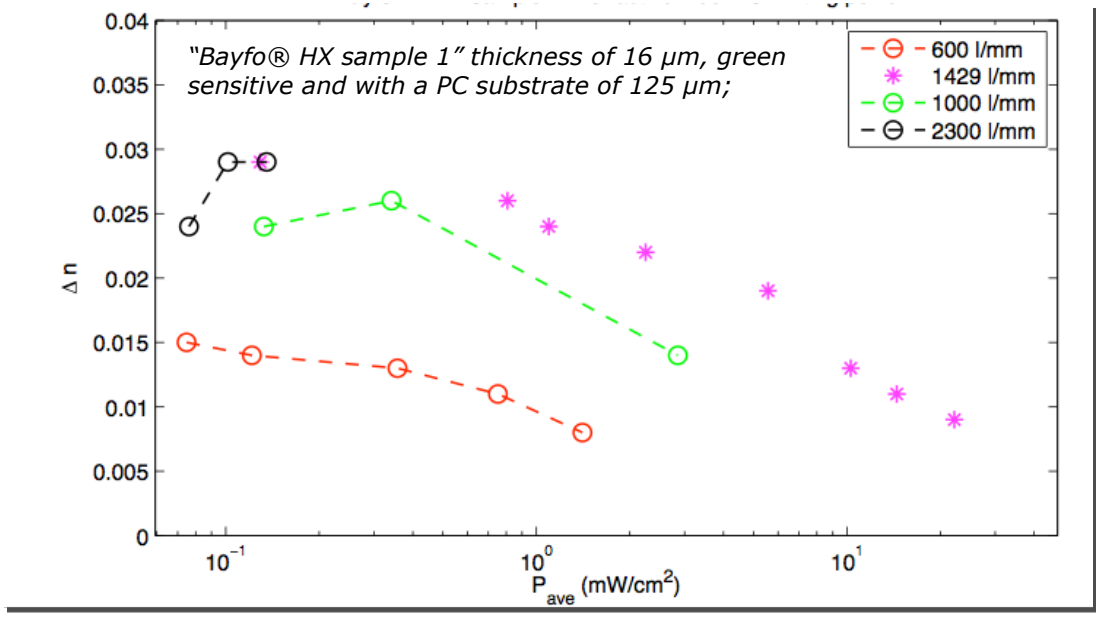
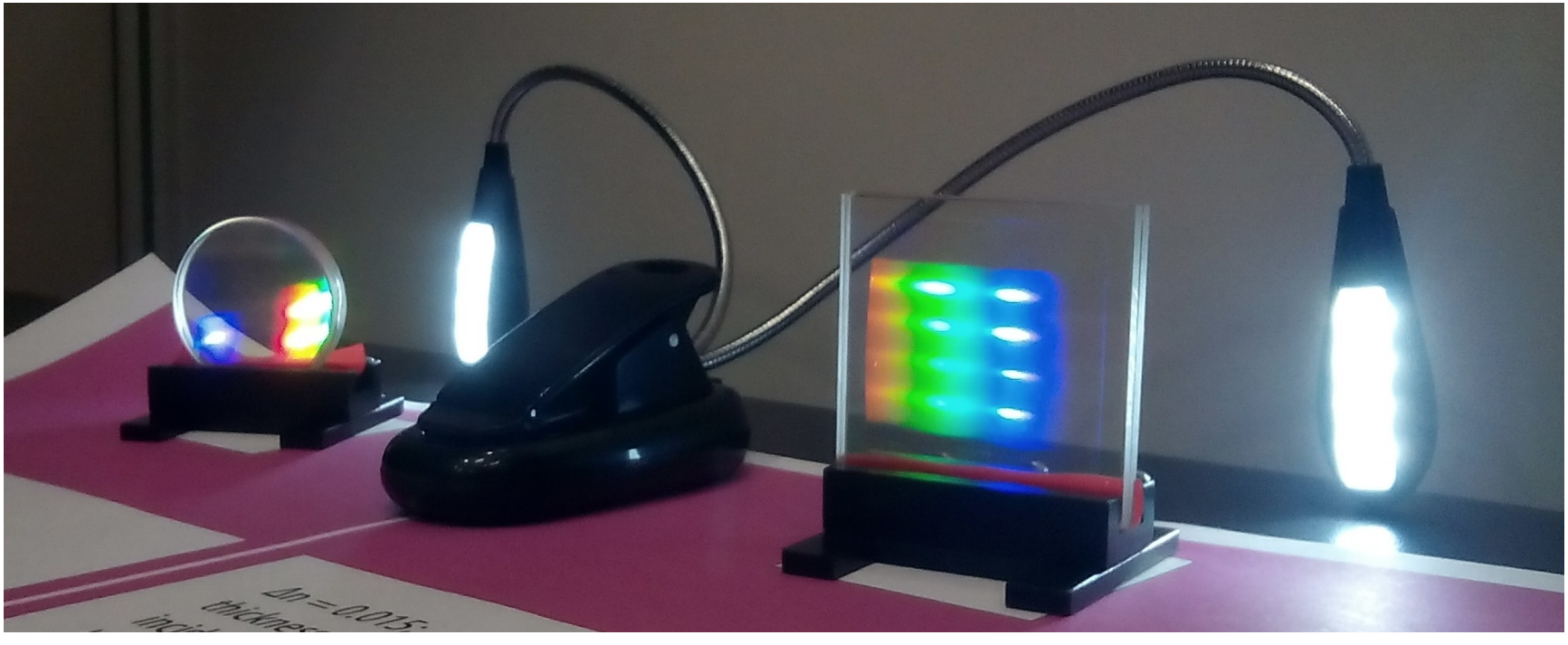


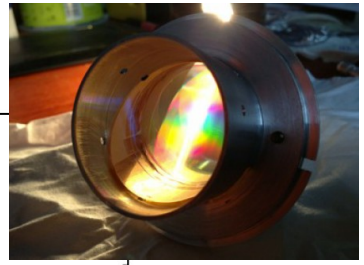
- Fine control of the Δn by means of the laser power, but smaller than Δn of DCG;

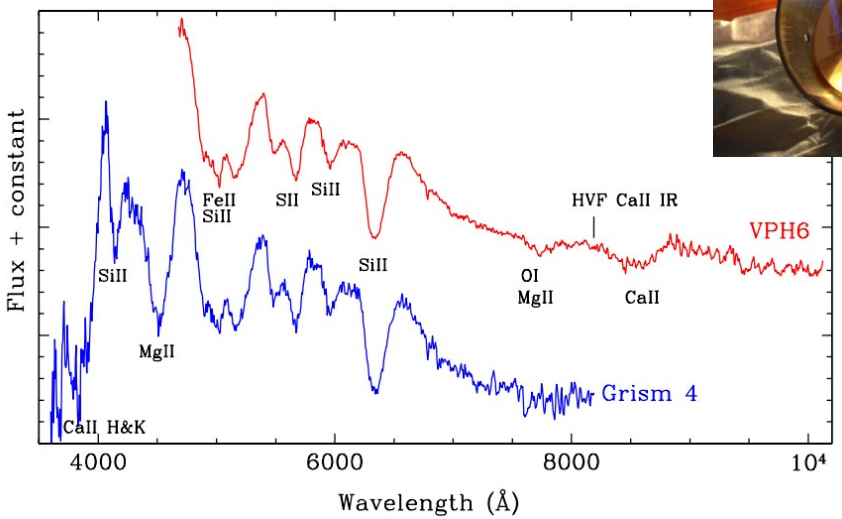
- Film thickness in the range 5 – 50 µm with a good homogeneity



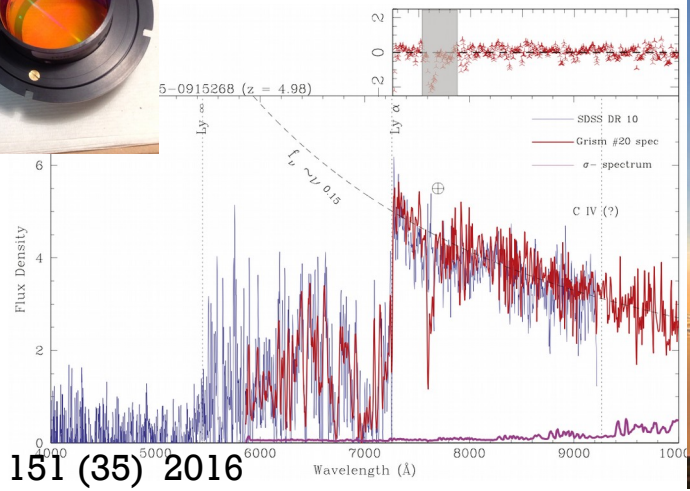
VPHGs for Astronomy based on Bayfol ®

AFOSC@ Copernico Telescope, Asiago, Italy





A. Zanutta et al, **PASP**, 126, 264 – 269, 2014

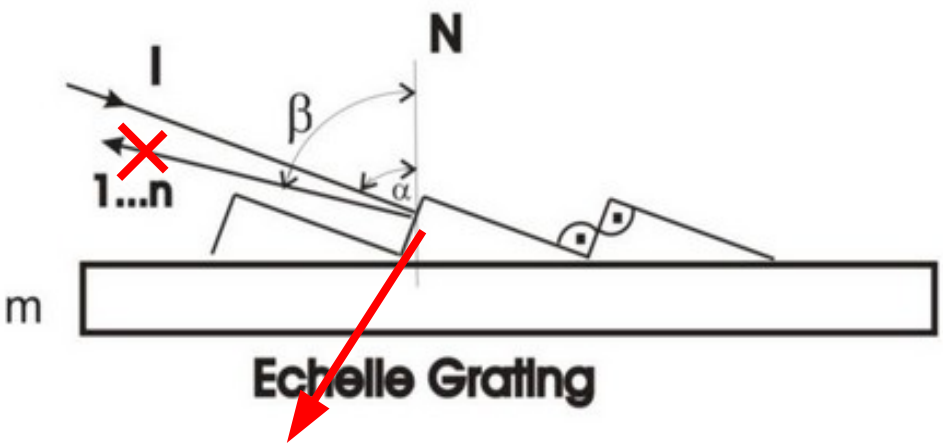


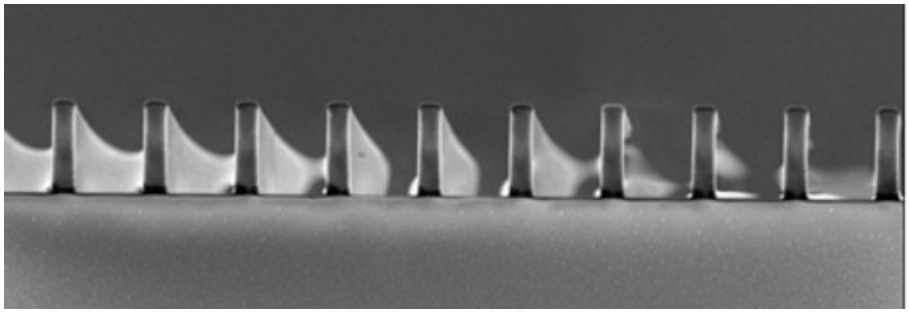
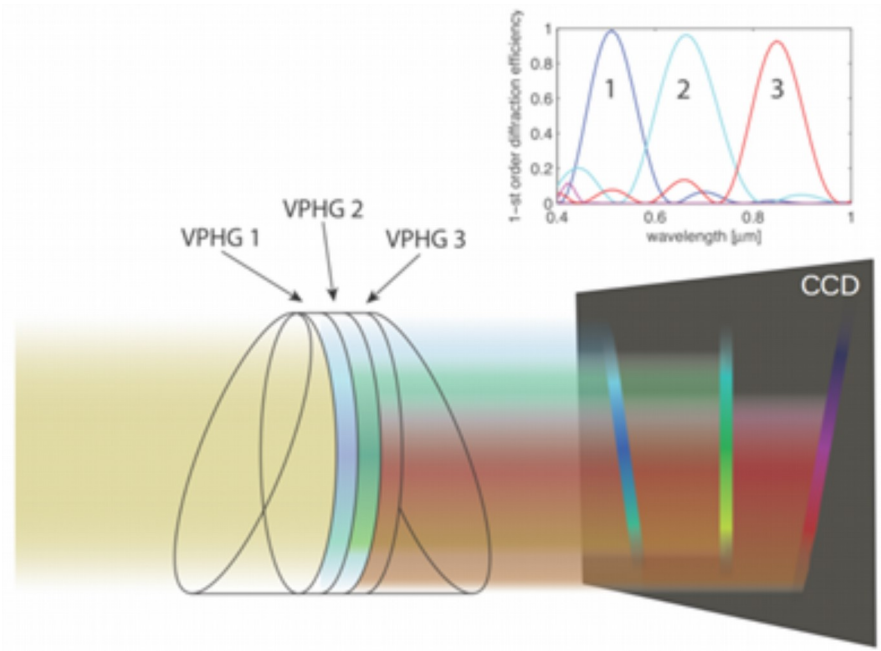
M. Landoni et al, **AJ**, 151 (35) 2016

ALFOSC@ Nordic Optical Telescope, La Palma, Spain

Future developments

Transmission Echelle gratings
Compact high resolution spectrographs.





Multifunctional gratings
Making the instrumentation simpler.