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# DIRECT LASER RECORDING OF DOT HOLOGRAMS ON AMORPHOUS SILICON FILM

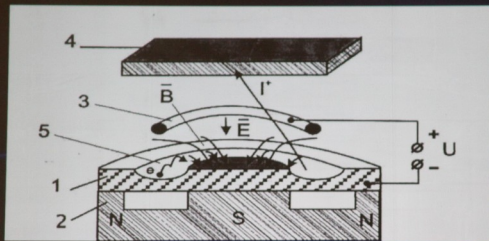
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Sydyk uulu

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# Outline

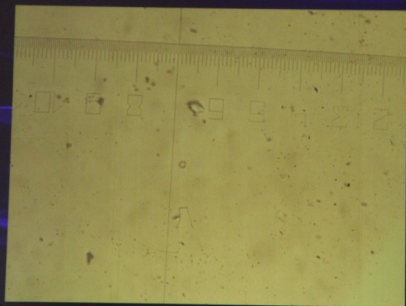
1. Introduction
2. Magnetron sputtering of amorphous silicon film and study of their absorption spectra
3. Scanning laser writing system
4. Direct laser recording to a-Si by Blue ray laser
5. Relief measurement
6. Summary

Vacuum planar equipment for magnetron sputtering of metallic films



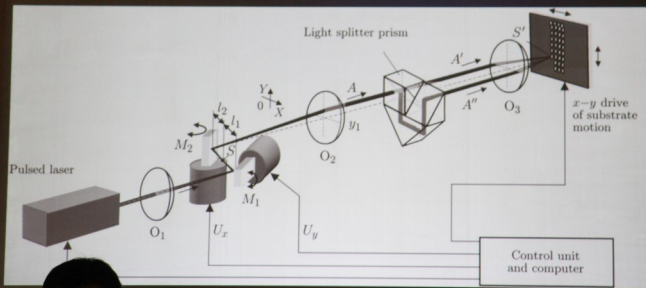
- 1 — катод-мишень;
- 2 — магнитная система;
- 3 — анод;
- 4 — подложка;
- 5 — зона распыления

# Magnetron sputtering of uniform a-Si films

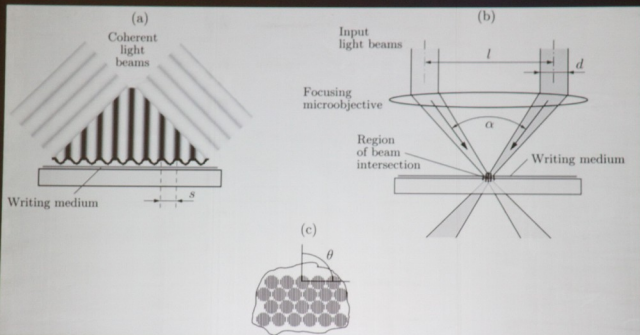


## Optical scheme of the SIL writing channel

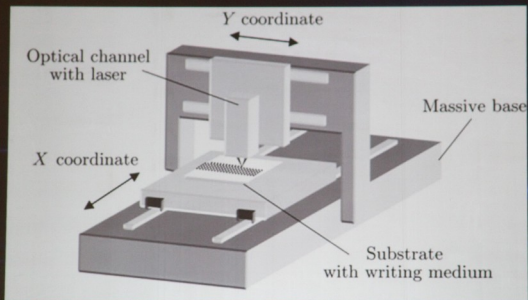
Eurasian Patent No. 007874, Publ. 2007, Bul. No. 1.  
“Device for Writing Diffractive Elements”



## Formation of the periodic structure by two coherent beams



## Structure of the system of interference lithography

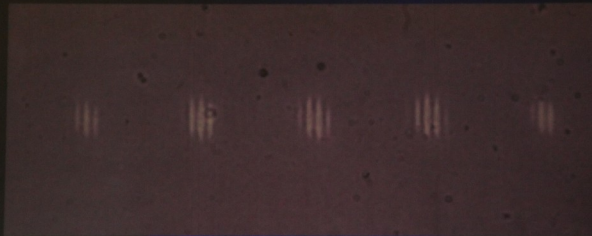


## Photo of the experimental set up





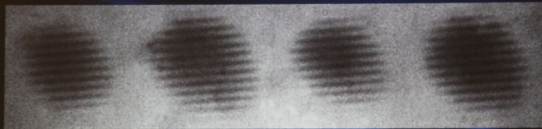
Photos of diffraction gratings recorded by  
pulse UV-laser ( $\lambda = 355 \text{ nm}$ ) on a-Si film



3D image of diffractive structure recorded on  
a-Si film



Photos of micro gratings recorded on a-Si film on ceramic substrate



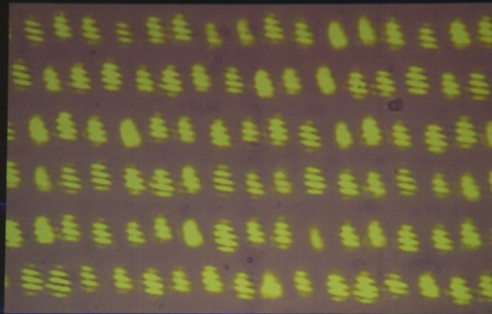
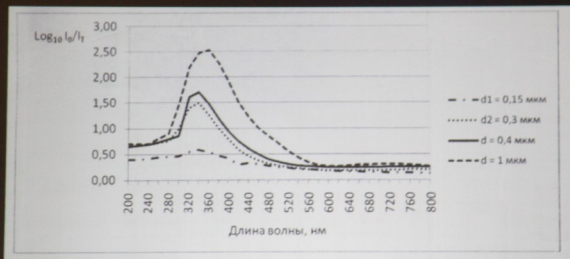
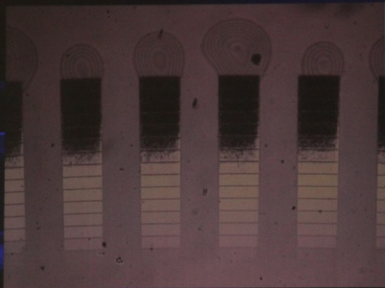


Photo of diffractive elements recorded on a-Si film on glass substrate

## The absorption spectra of a-Si films with different thickness

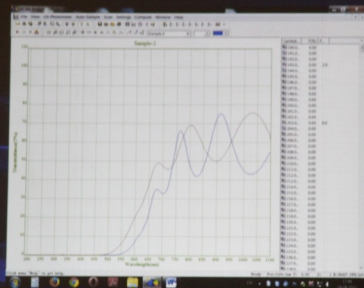


Test recording on CLWS-300IAE laser writing system at the lab.  
of Prof. Poleshchul A.G. (IAE Siberian branch of RAS,  
Novosibirsk) Microscope INTERFAK



Условия записи: Длина волны – 532нм; Скорость вращения – 12 об/сек  
Размер пучка – 0.5 мкм (FWHM)  
R=5мм (Объектив 25x) 40/2/20 Pref=65

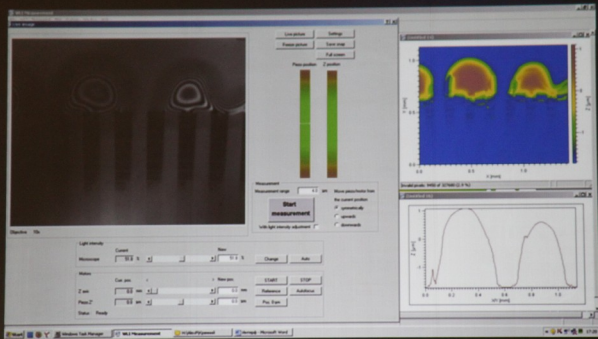
Changing the refractive index of the silicon film under the laser radiation interaction. The shift of the transmission spectrum maxima is appear.



The red curve – unexposed silicon

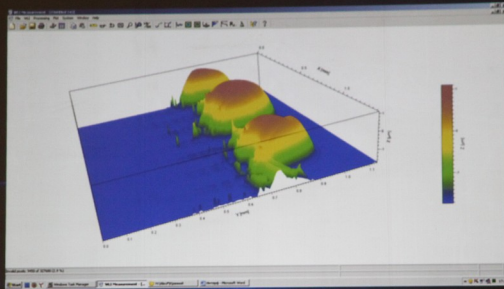
Blue curve - the exposed portion (5x5 mm square) Spectrophotometer UNICO 2800.

Measurement of recorded sample on scanning interferometric microscope  
in white light VLI regime – on reflection. Objective – 50x





## 3D image

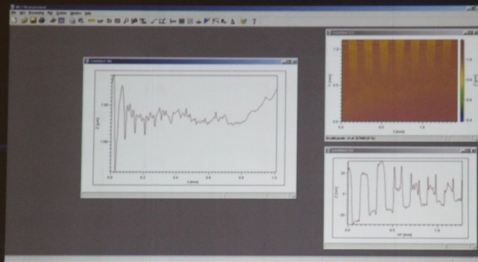


Under interaction of laser radiation amorphous silicon transforming to crystalline silicon with volume increasing.

Distance between atoms of a-si :  $1.54 \text{ \AA}$ ,

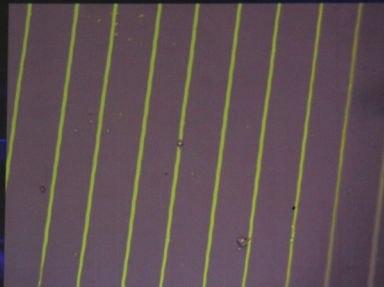
for crystalline silicon distance between atoms :  $5.431 \text{ \AA}$ .

## Measurement of recorded relief

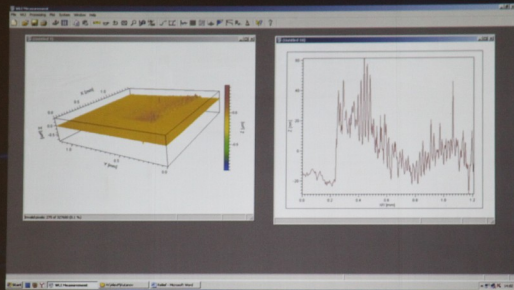


under laser radiation interaction relief formed with value 20 -30 HM.

Direct laser recording on a-Si film using  
Blu ray laser (single mode Mitsubishi 120 mW laser)

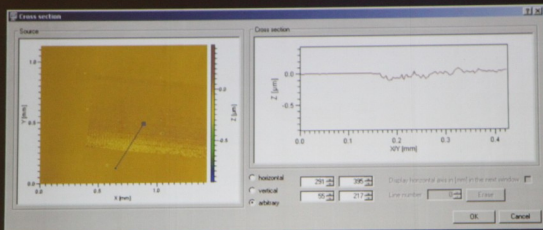


# Relief Measurement



VLI Lab Wight light interferometer  
10x – objective

# Relief Measurement



## Possible applications

- Dot Matrix Holograms Fabrication
- Interference lithography
- Digital Holography
- Security applications (read only security ID cards)
- Antireflective Submicrometer Surface-Relief Gratings

## Summary

- Developed Direct laser recording on a-Si film provides following advantages: fast process of recording by pulse UV-laser and it's not require chemical processing; high resolution; read only process without rewriting opportunity
- developed scanning system of interference lithography provide diffractive microstructures recording from microgratings with an arbitrary orientation and a period of 0.6 to 1.5  $\mu\text{m}$  with a total size up to 300 mm
- It was demonstrated possibilities of direct laser recording by laser radiation with  $\lambda = 355\text{nm}$ ,  $\lambda = 405\text{nm}$  and  $\lambda = 532\text{nm}$
- Possible application:
  - Dot Matrix Holograms Fabrications
  - Interference lithography
  - Security applications (read only security ID cards)
  - Antireflective Submicrometer Surface-Relief Gratings

Thank you for your attention!

