CONFOCAL SPECTROMICROSCOPY OF AMORPHOUS AND NANOCRYSTALLINE TUNGSTEN OXIDE FILMS

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State-of-the-Art

- "Blu-ray" disks, having capacity of more than 25 GB per recording layer, use a 405 nm laser, focussed through a high numerical aperture (NA=0.8-1.0) objective lens to a spot size of about 300 nm.

- The most frequently used rewritable phase change recording materials, belong to the group of semiconductor chalcogenides.

  For example: ternary GeSbTe and quaternary AgInSbTe alloys.

- Other materials - tungsten oxides:

  - a reversible photoredox reaction under two-wavelength laser excitation of tungsten oxide in air

    J.M. Osman, R.J. Bussjager, F. Nash, J. Chaiken, R.M. Villarica, Appl. Phys. A 66 (1998) 223.

  - heat treatment of WO_3/metal thin-film bilayered structures

    Y. Takeda, N. Kato, T. Fukano, A. Takeichi, T. Motohiro, S. Kawai, J. Appl. Phys. 96 (2004) 2417.

  - rewritable electrically selective multi-layered optical recording disk, based on the electrochromic behaviour of WO_3

    R. Sato, N. Ishii, N. Kawamura, H. Tokumaru, in: Proc. 3rd European Symp. on Phase Change and Ovonic Sci., Balzers, Liechtenstein, September 04-07, 2004.

  - write-once optical recording was demonstrated in WO_2 film

    T. Aoki, T. Matsushita, A. Suzuki, K. Tanabe, M. Okuda, Thin Solid Films 509 (2006) 107.

Present work goal

- To demonstrate the possible use of WO_3 & AWO_4 thin films for write-once phase change optical recording.

- To propose the multilayer AWO_4 phase-change media structure based on Raman scattering detection of the highest frequency stretching W-O mode.

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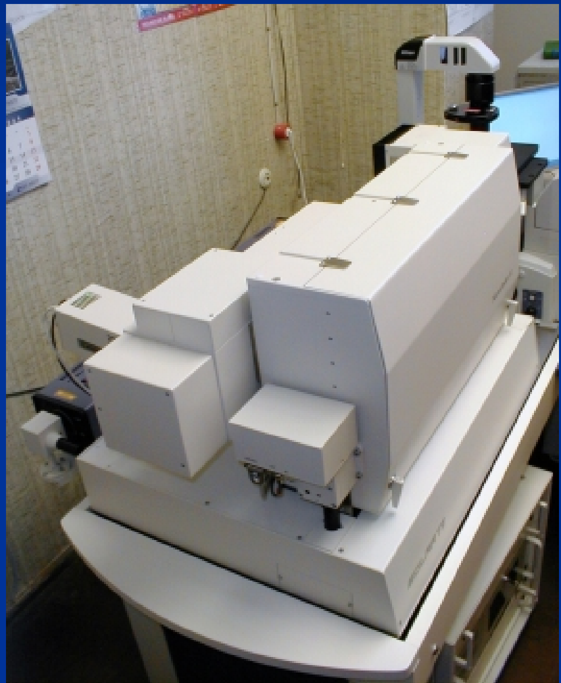
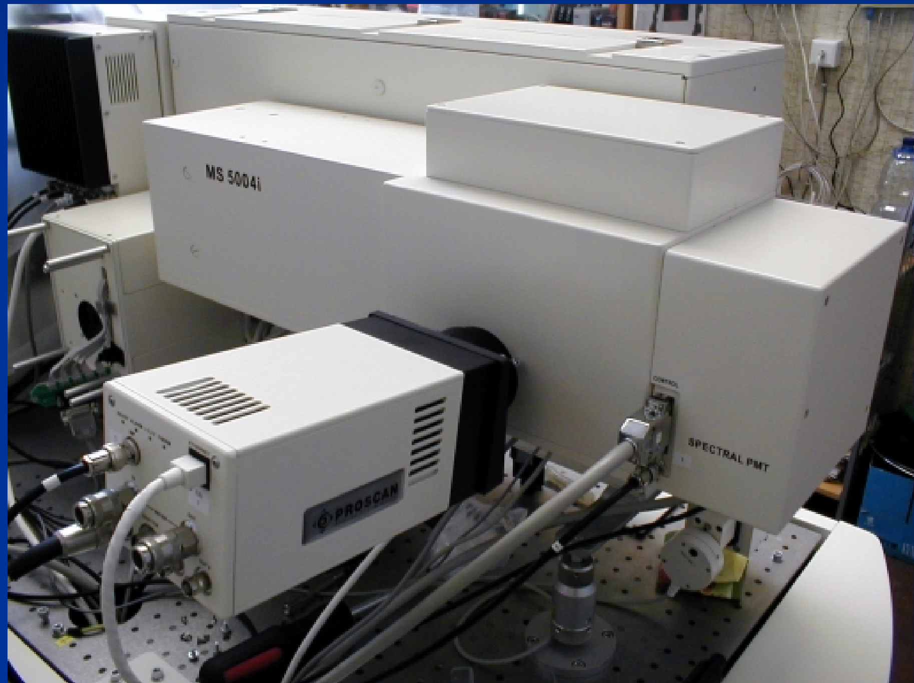
3D scanning confocal microscope with spectrometer *"Nanofinder-S"*

produced by SOLAR TII, Ltd.

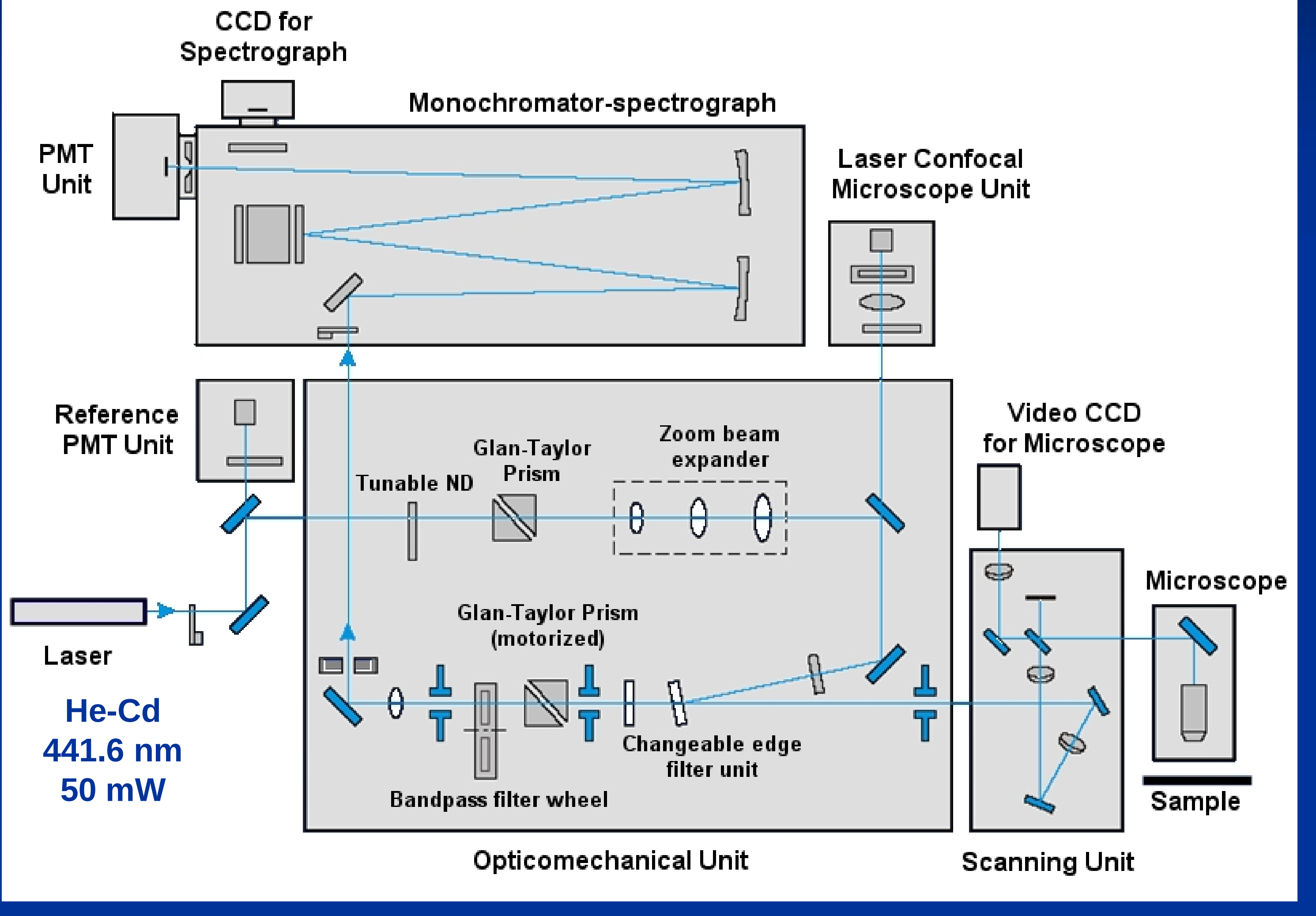




Simultaneous / Multifunctional Analysis:

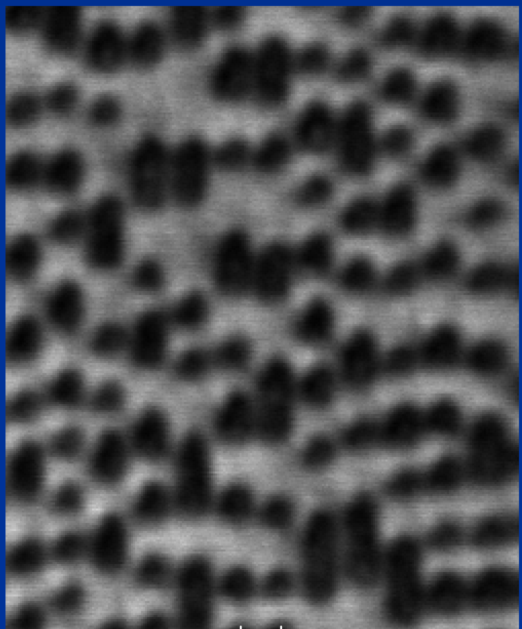
- Optical and Confocal Microscopy
- Raman Spectroscopy
- Luminescence Spectroscopy
- 0D, 1D, 2D & 3D High-speed Imaging and Spectroscopy

"Nanofinder-S" modular optical layout



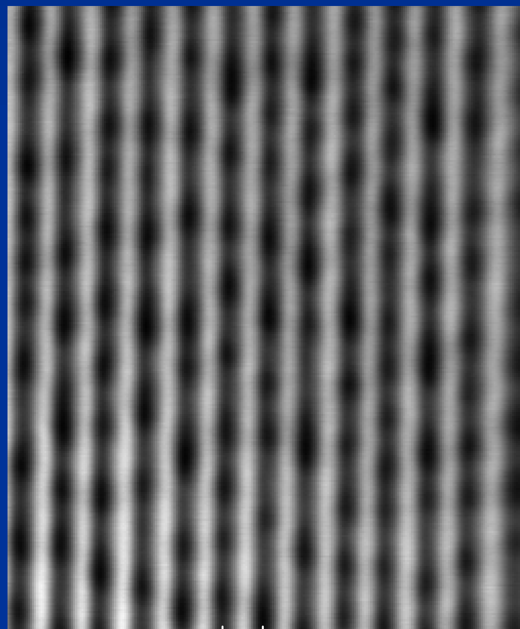
Commercial Compact Disk Imaging in Confocal Mode

CD-ROM



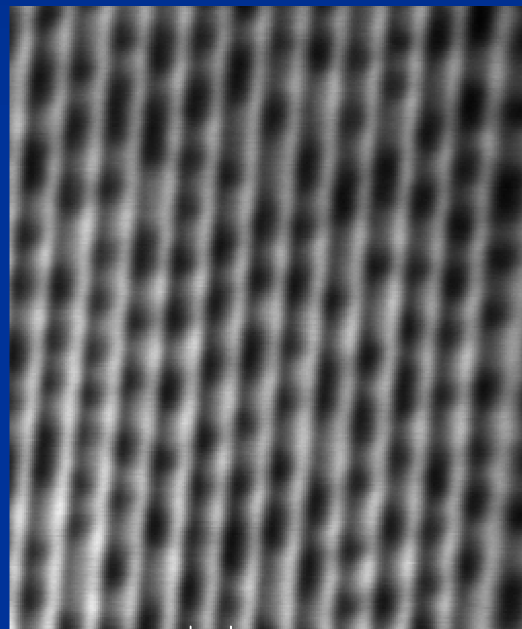
Track pitch = 1.6 µm

CD-R



Track pitch = 1.6 µm

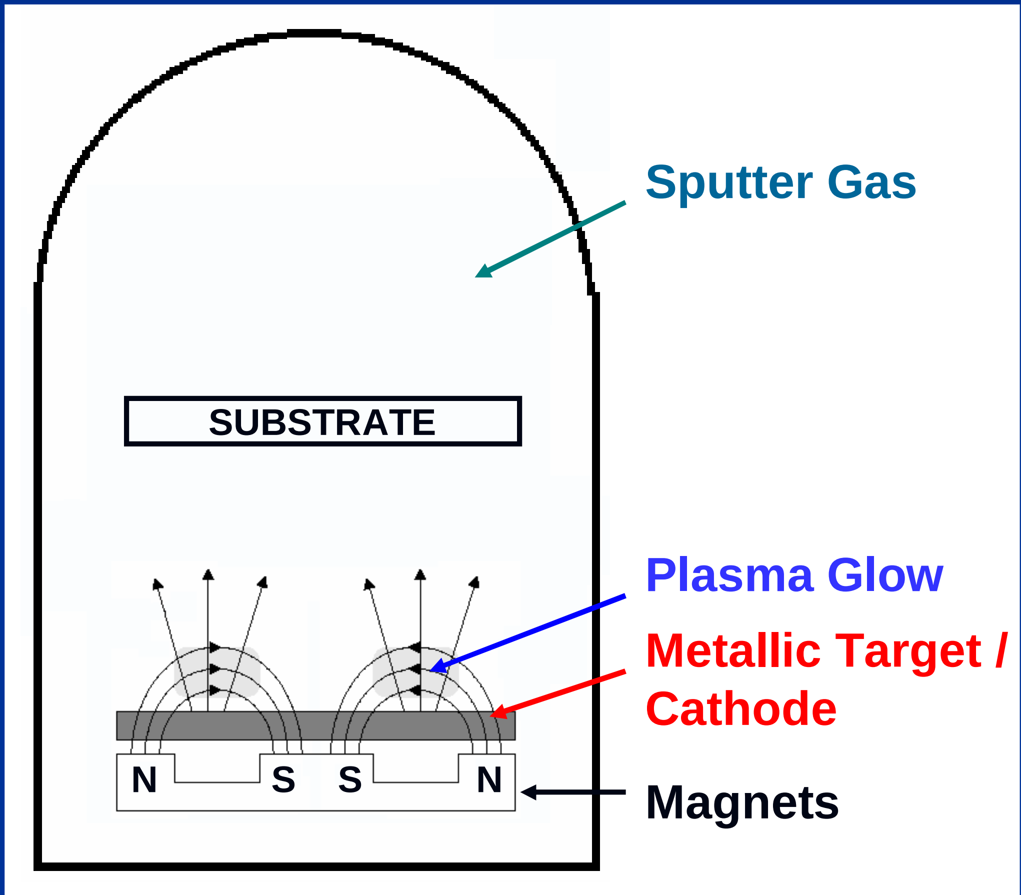
CD-RW



Track pitch = 1.6 µm

Images size: 20´24 µm

Thin Film Preparation by DC Magnetron co-Sputtering



Metallic targets:

- W (99.95%)
- Ni (99.0%)
- Zn (99.9%)

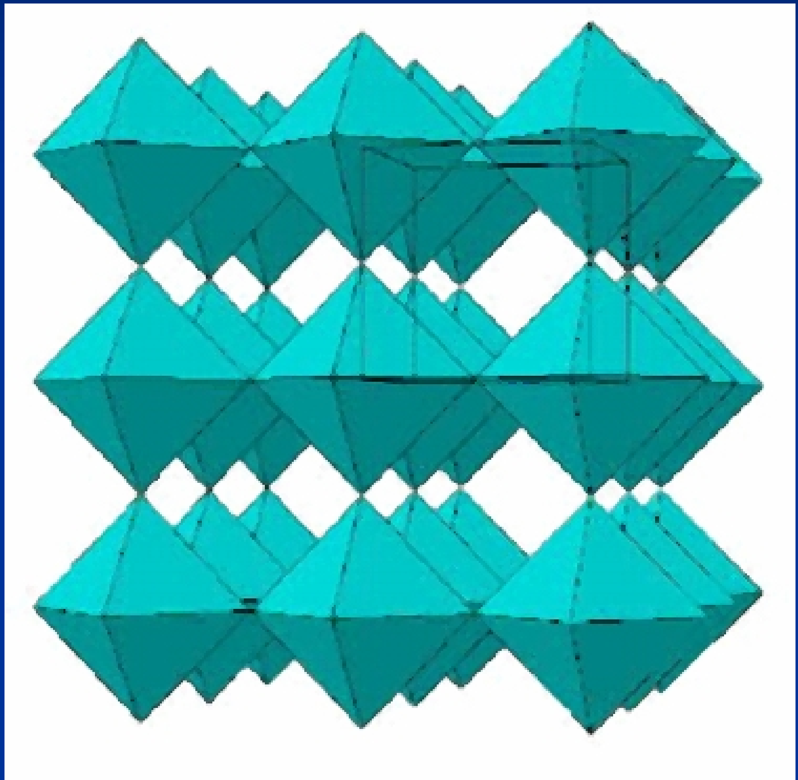
Substrates: Si, glass

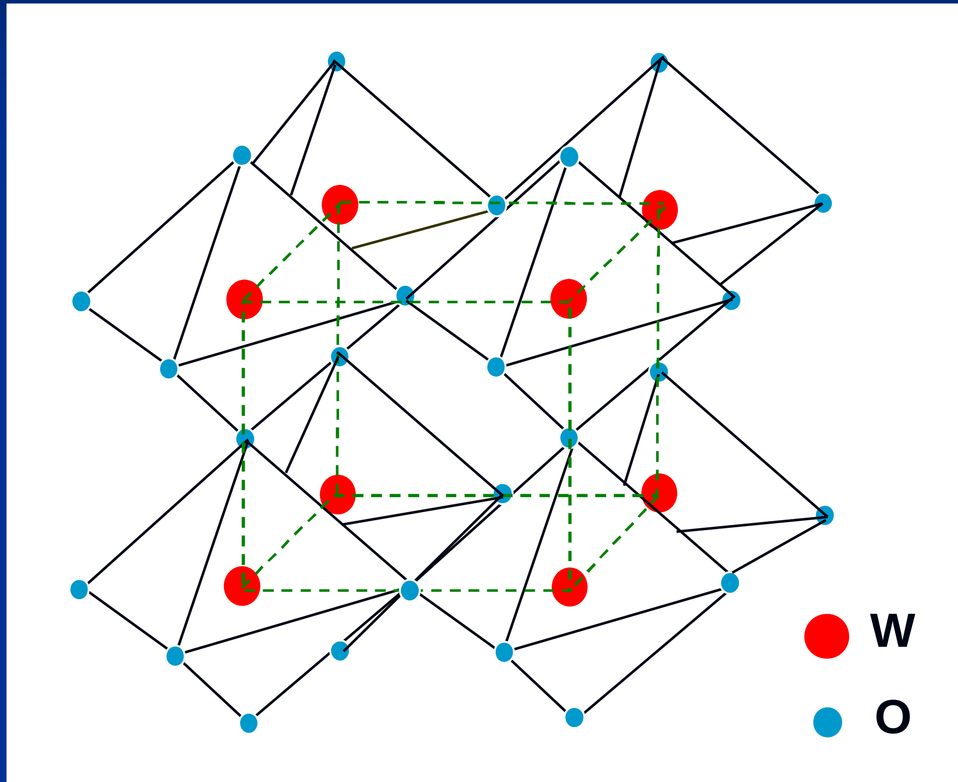
Sputter gas: Ar (80%) + O_2 (20%)

Total gas pressure: 6.7 Pa

Discharge power: 100 W

Crystalline Structure of WO_3

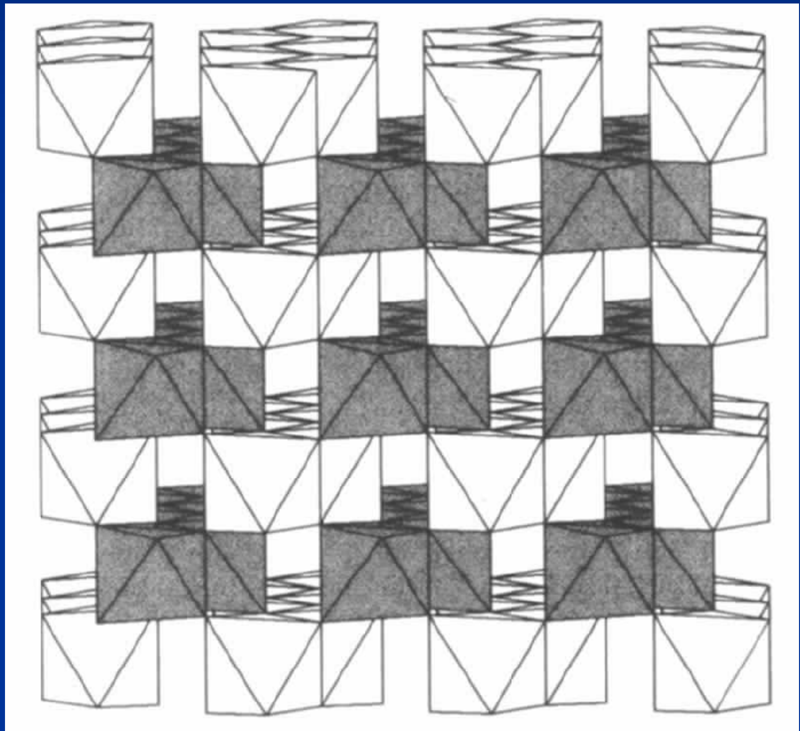


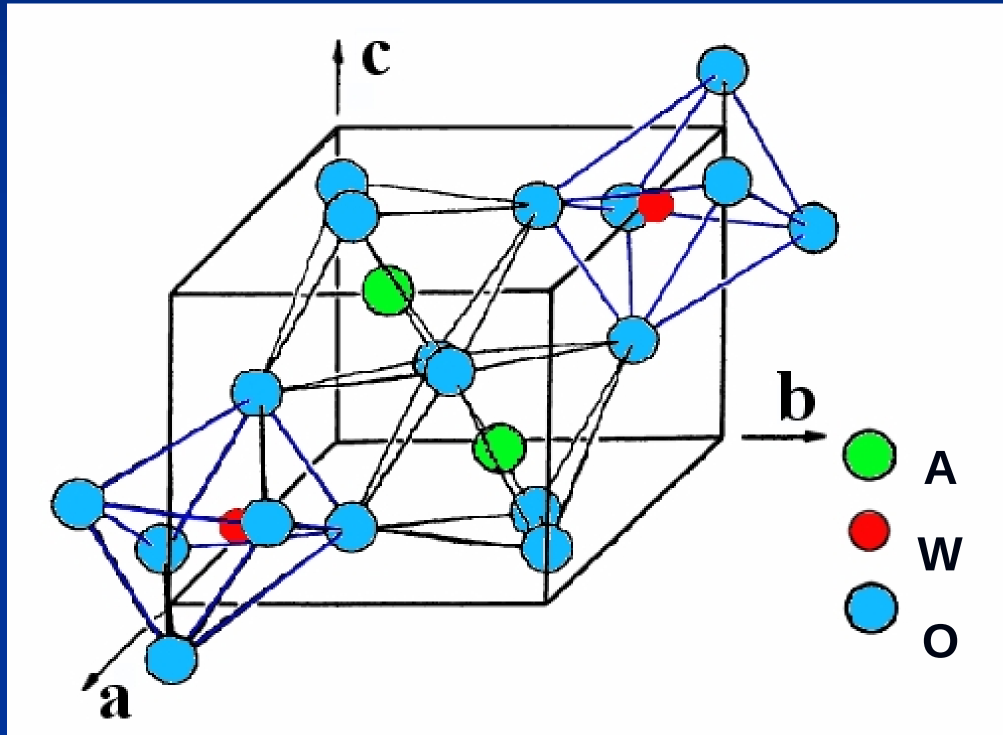


WO_3: $[WO_6]$

Well known electrochromic material based on valence change of tungsten ions:
W^{6+} (transparent) ® W^{5+} (blue)

Crystalline Structure of AWO_4
(A = Ni, Zn)



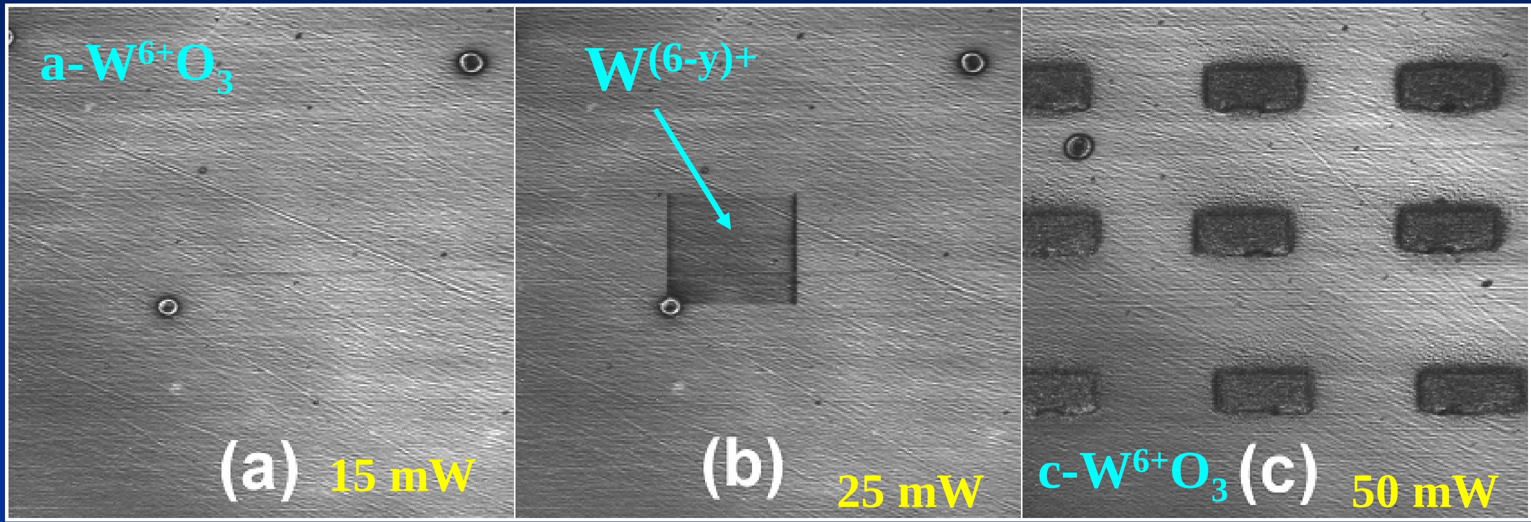


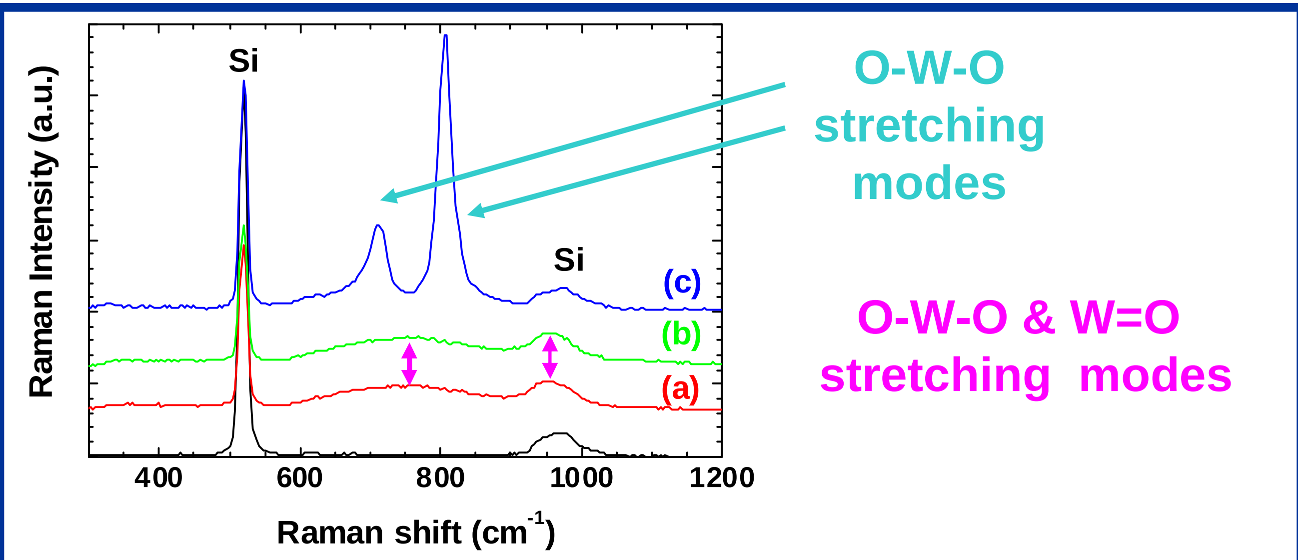
AWO_4: $[AO_6]$ & $[WO_6]$

Tungstates are known as scintillators and Raman shifters.

Optical Recording in t.f.-WO_3

Confocal images:
274 mm × 333 mm

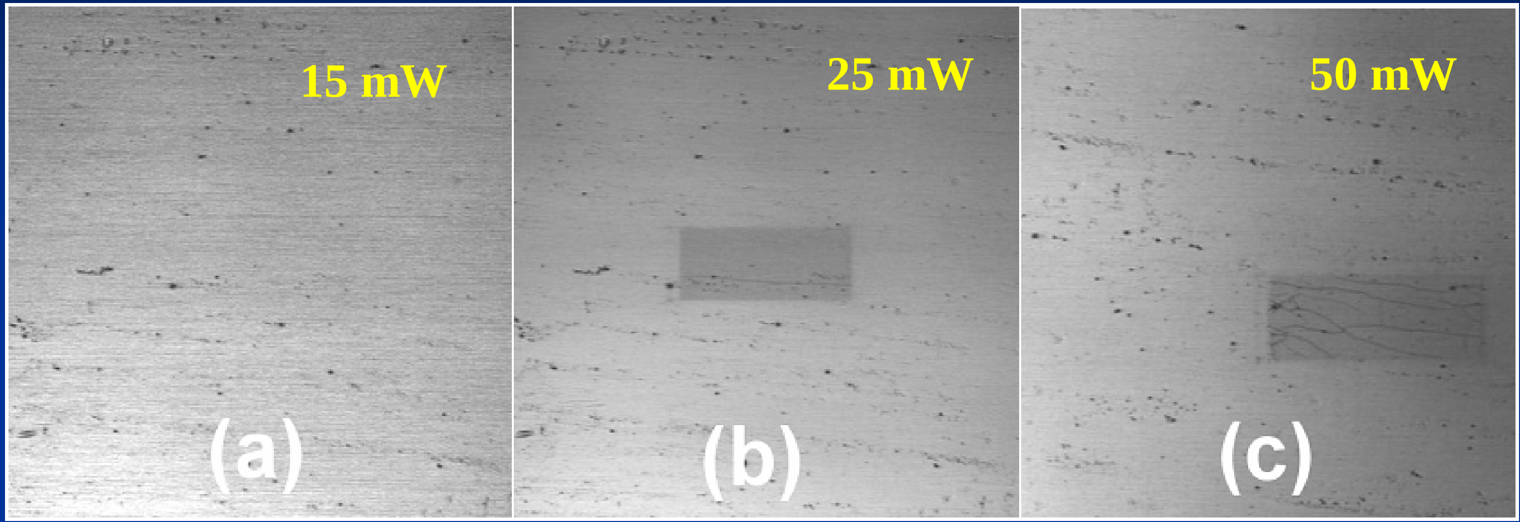


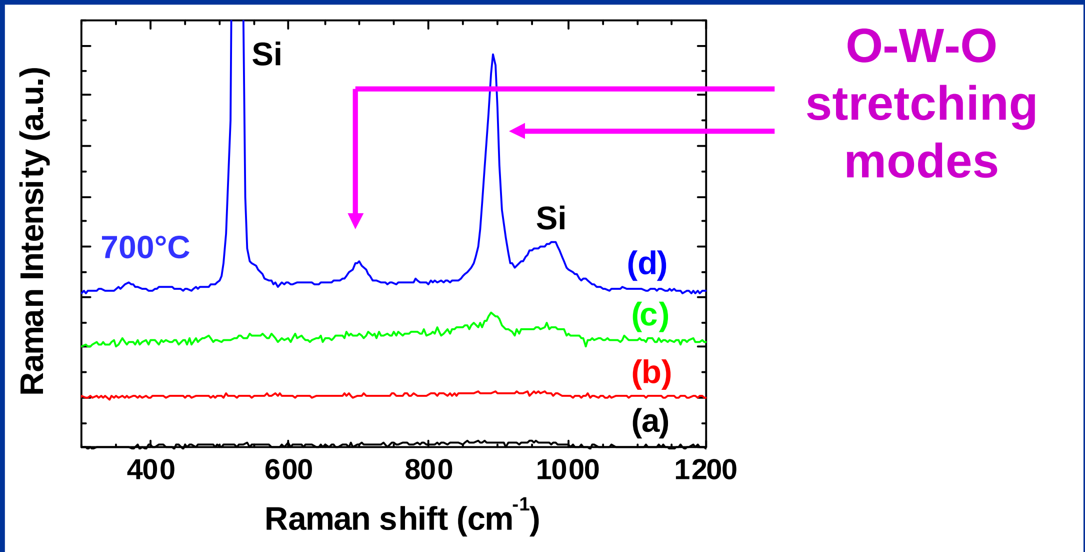


* A. Kuzmin, J. Purans, E. Cazzanelli, C. Vinegoni, G. Mariotto, J. Appl. Phys. 84 (1998) 5515.

Optical Recording in t.f.-$NiWO_4$

Confocal images:
134 mm × 167 mm





* A. Kuzmin, J. Purans, R. Kalendarev, D. Pailharey, Y. Mathey, Electrochim. Acta 46 (2001) 2233.

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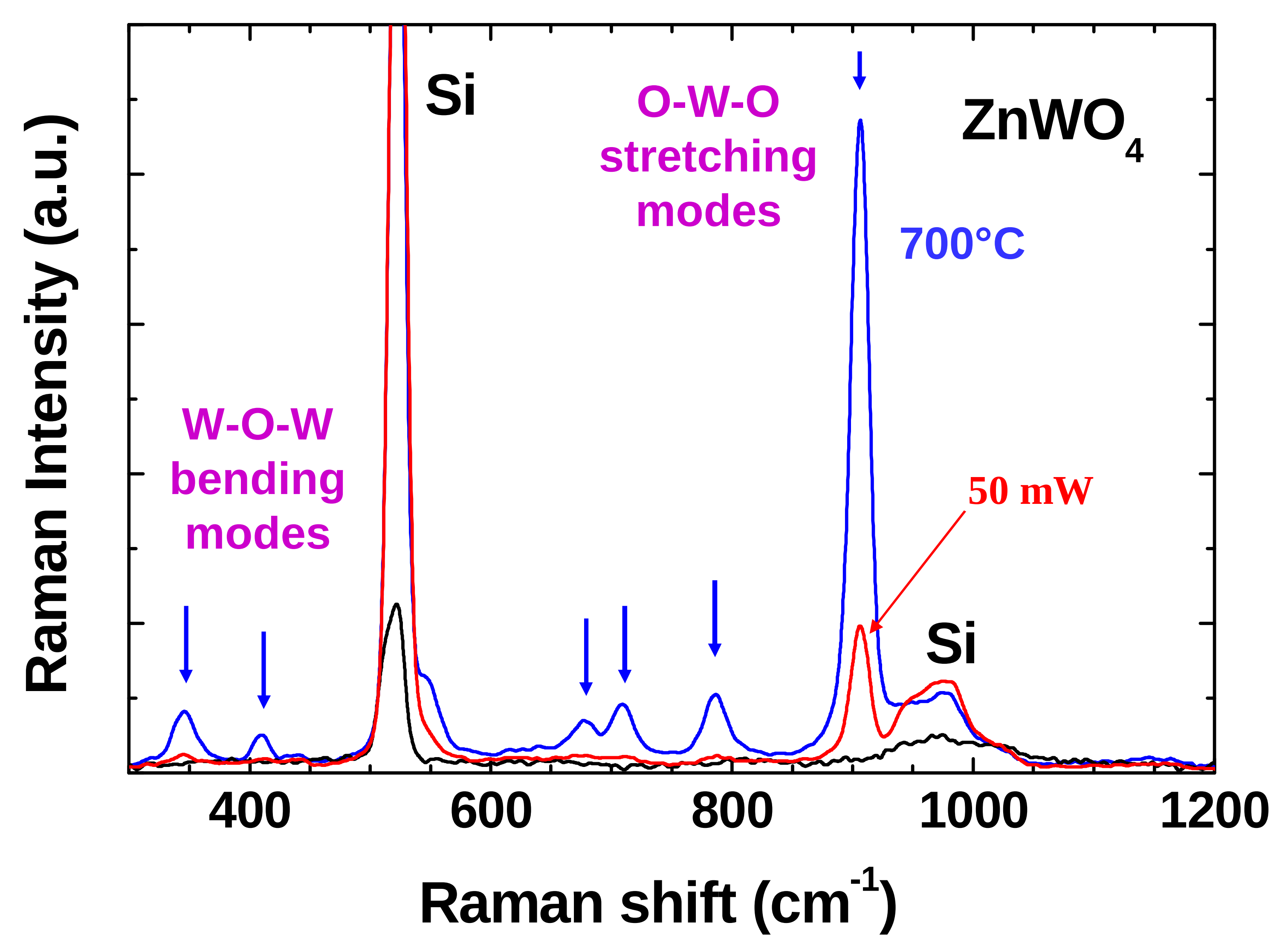
Optical Recording in t.f.-$ZnWO_4$



Possible Mechanisms of Optical Recording in Tungsten Oxides

$W^{6+}O_{3-x}$ & $AW^{6+}O_{4-x}$ (A = Ni, Zn)

Formation of metastable color centers W^{6+} ® $W^{(6-y)+}$

- short term life time in air

Change in reflectivity

(10-20%)

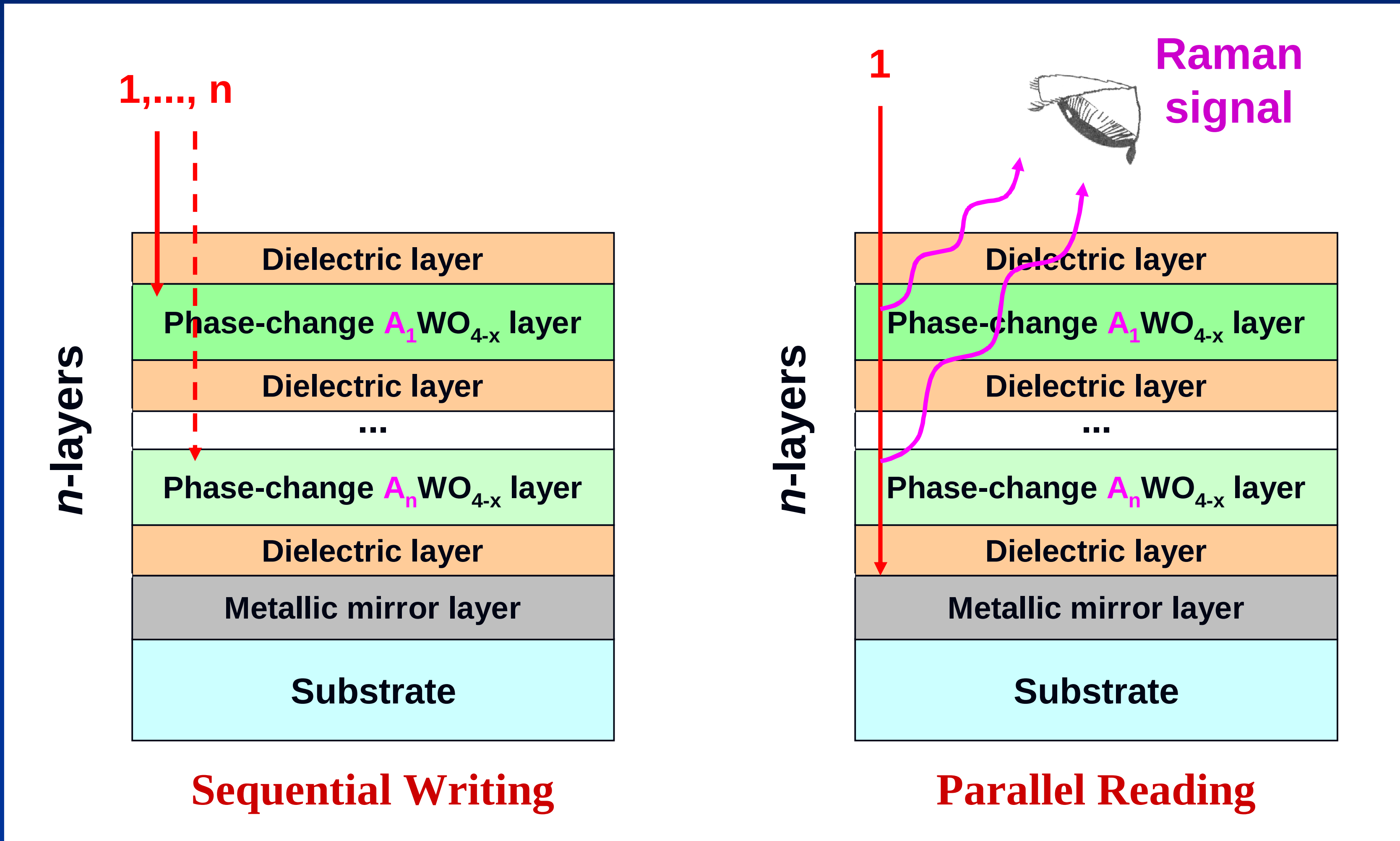
Crystallization to WO_3 / AWO_4

- long term life time
- good thermal stability

Change in phase & reflectivity

Multilayer phase-change media structure based on Raman scattering detection

Multilayer write-once phase-change media structure based on Raman scattering detection



AWO_4 band gap ~ 3.0-3.8 eV

Thank you !

For more information look at the Internet:
http://www.cfi.lu.lv/exafs

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