Surface-Enhanced Raman Optical Data Storage (SERODS): A New Approach for High-Density Optical Data Storage

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Presentation by

Randall Wetherington (ORNL)

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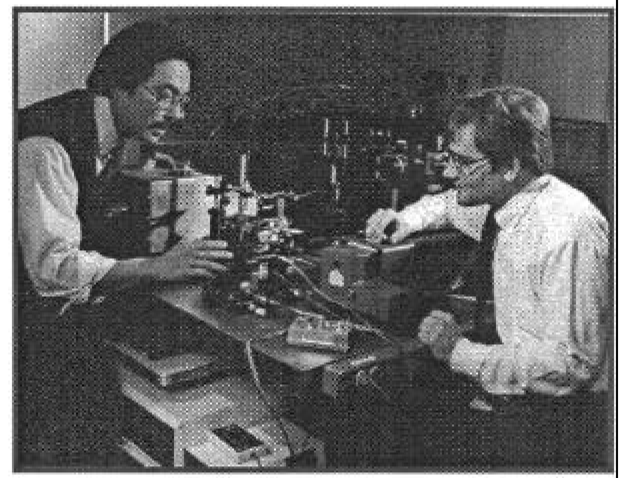

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SURFACE-ENHANCED RAMAN OPTICAL DATA STORAGE (SERODS)

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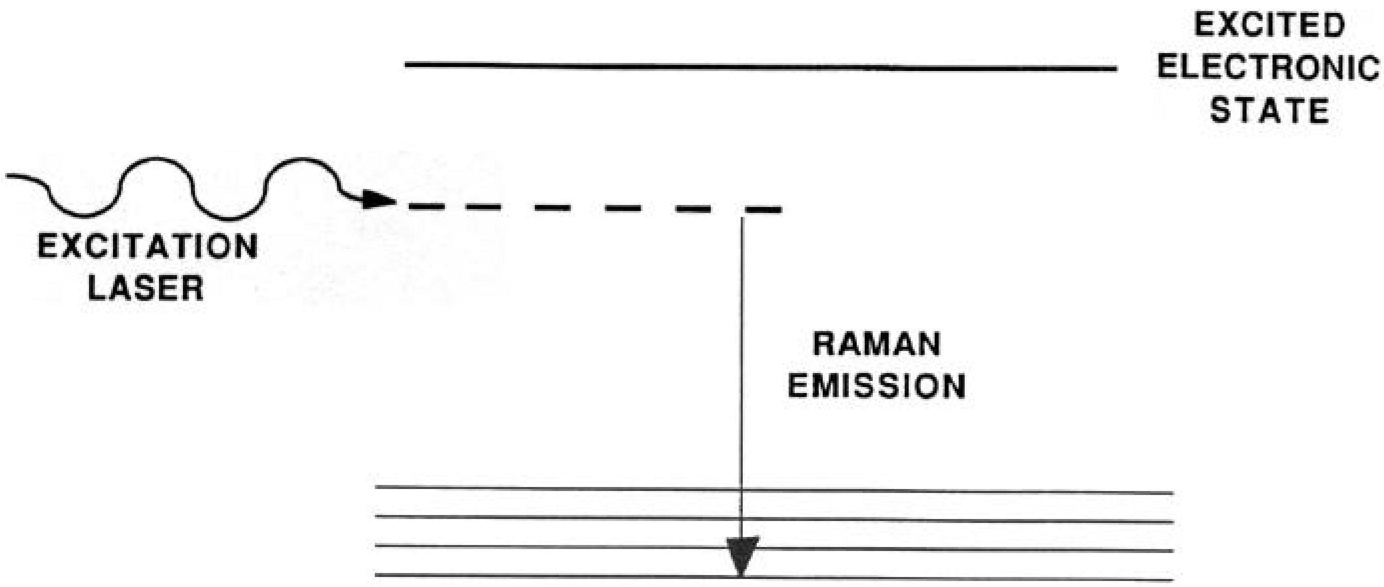
RAMAN EMISSION



- Raman Intensity is proportional to the Electric Field-Induced Dipole Moment, P, where

$$P = \alpha * E$$

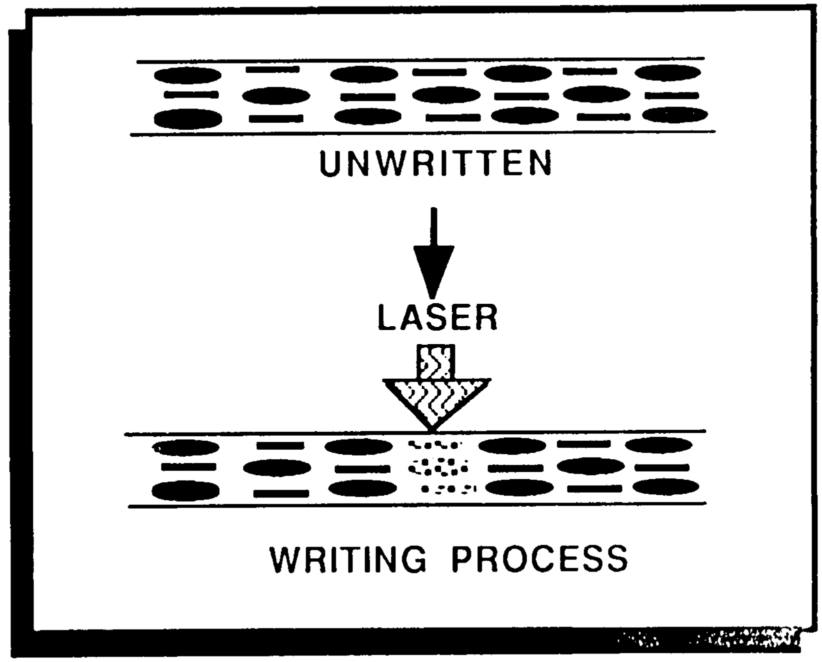
α = Molecular Polarizability

E = Electric Field Incident Upon The Molecule

NEW CONCEPT FOR OPTICAL DATA STORAGE

- SURFACE-ENHANCED-RAMAN OPTICAL DATA STORAGE (SERODS) SYSTEM

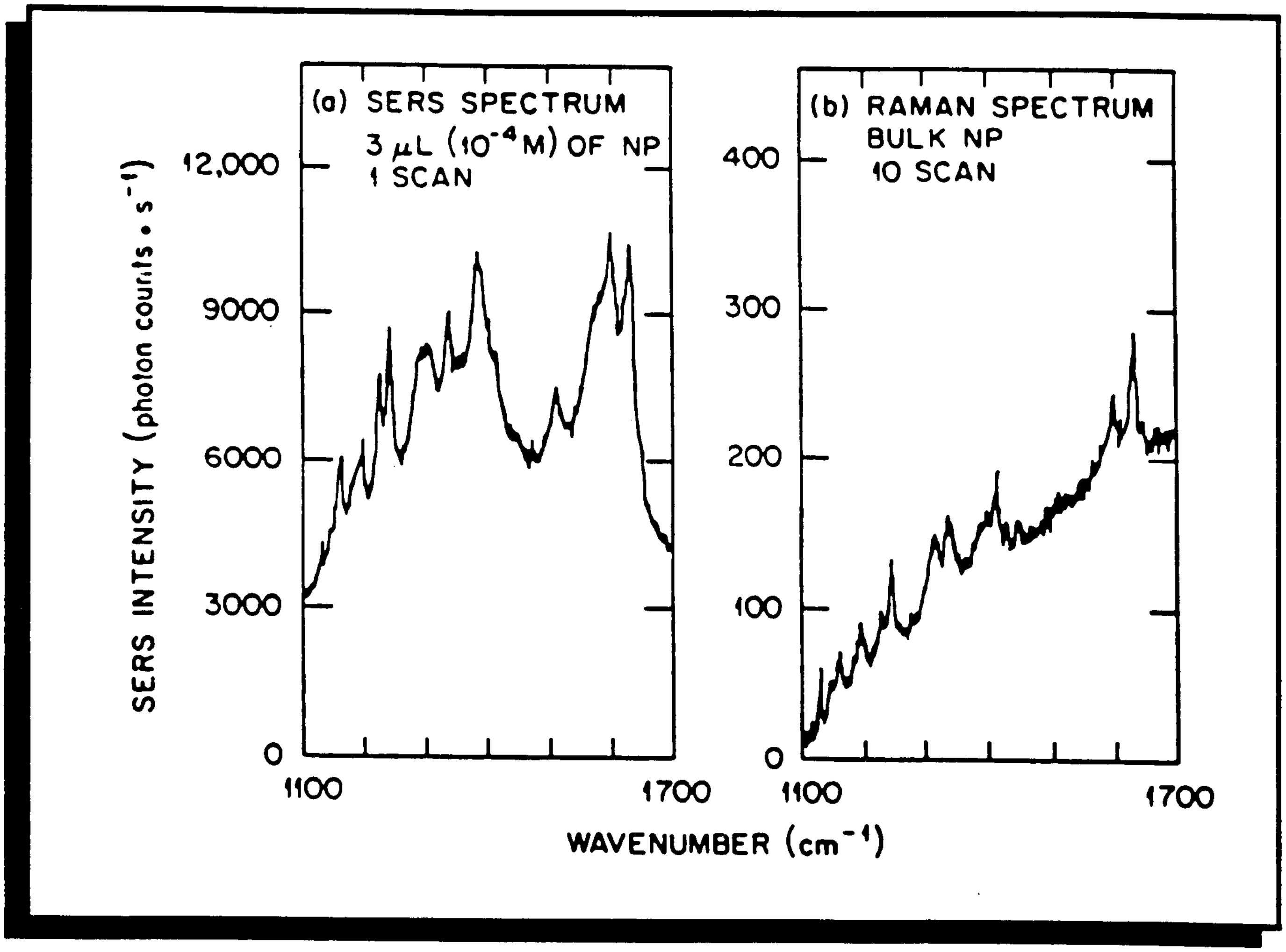
- MOLECULAR ALTERATION OF MEDIUM BY LASER OR OTHER RADIATION



- DETECTION OF MOLECULE/MEDIUM INTERACTION = DATA BIT

- THEORETICAL LIMIT; SINGLE MOLECULE COULD REPRESENT ONE BIT

ORNL-DWG 5294



SURFACE-ENHANCED RAMAN EFFECT

RECENT STUDIES HAVE DISCOVERED THAT THE RAMAN CROSS-SECTION CAN BE ENHANCED BY FACTORS UP TO 10^8 WHEN A COMPOUND IS ADSORBED ON OR NEAR ROUGH METAL SURFACES

ELECTROMAGNETIC MODELS FOR SERS

SURFACE PLASMONS

"LIGHTENING ROD" EFFECT

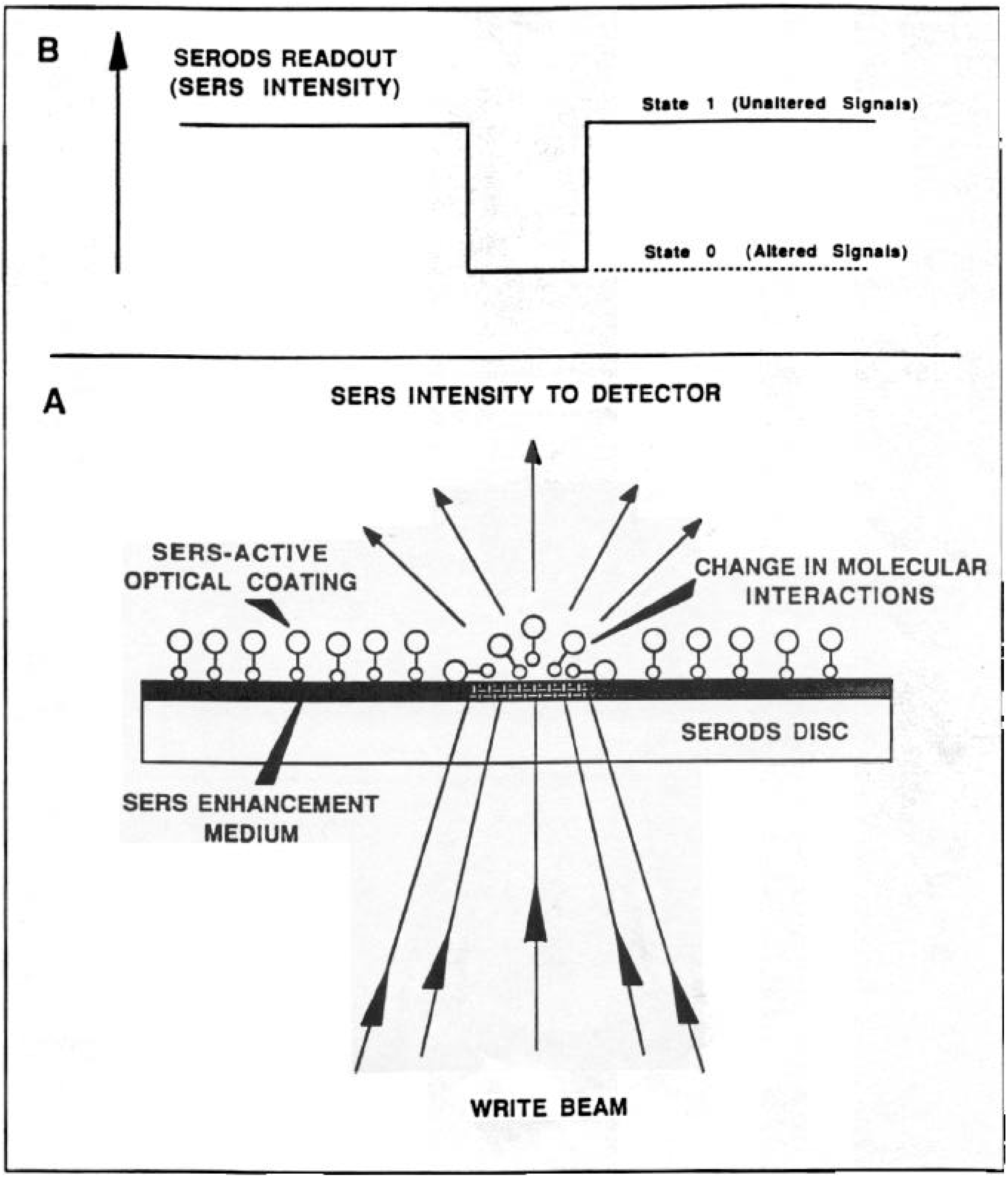
POLARIZATION OF THE SURFACE BY DIPOLE-INDUCED FIELDS IN ADSORBED MOLECULES ("IMAGE EFFECT")

CHEMICAL EFFECTS IN SERS

OVERLAP OF METAL AND ADSORBATE WAVEFUNCTIONS (CHARGE-TRANSFER PROCESSES)

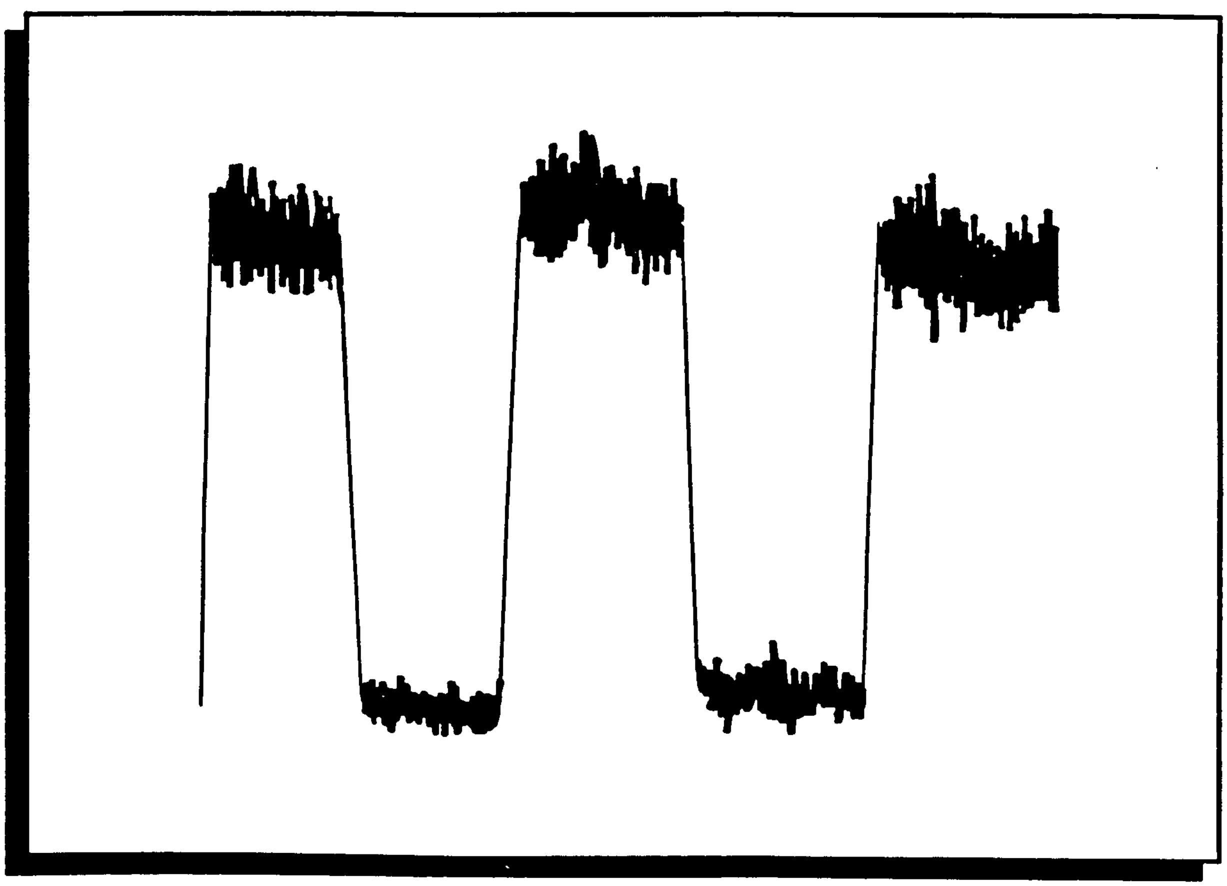
ADSORPTION EFFECTS

SERODS PROCESS



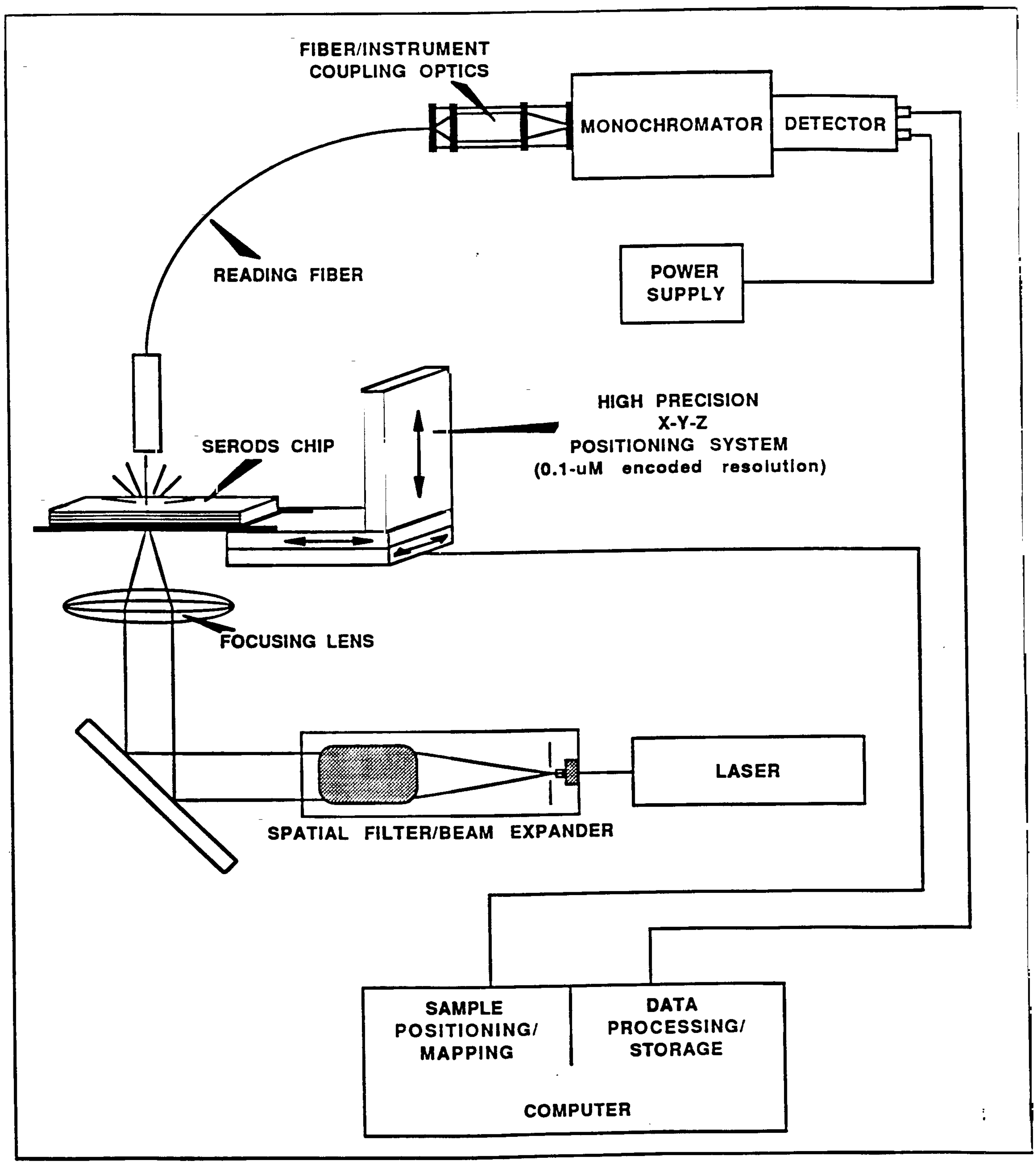
TECHNICAL APPROACH OF SERODS

The approach is based on the surface-enhanced Raman optical data storage (SERODS) technique, whereby the Raman signal of molecules adsorbed on special metallic substrates are enhanced up to several million times. A write laser is used to modify the molecular interactions of the molecule/substrate and to change the Raman signal for encoding information.

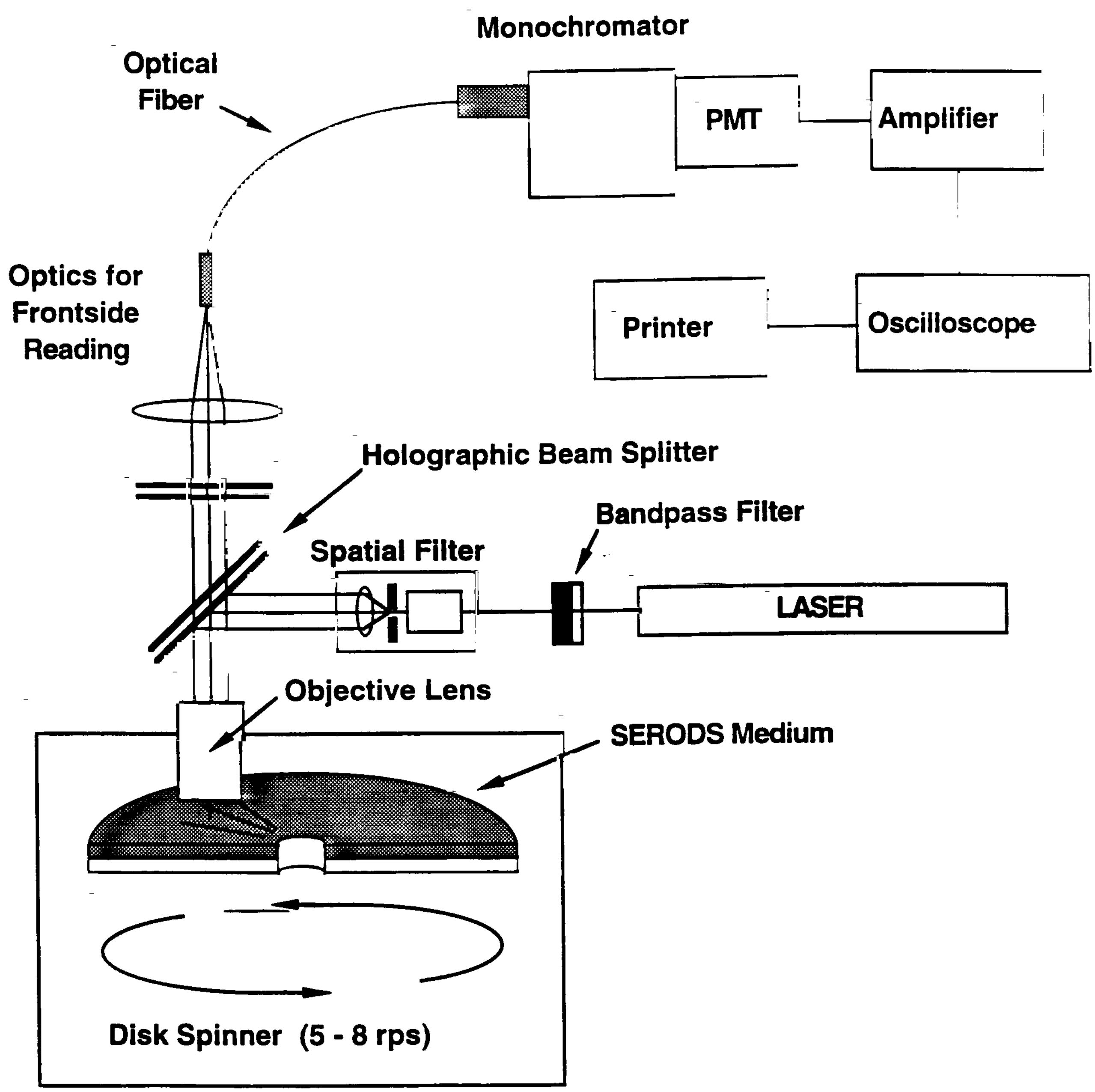


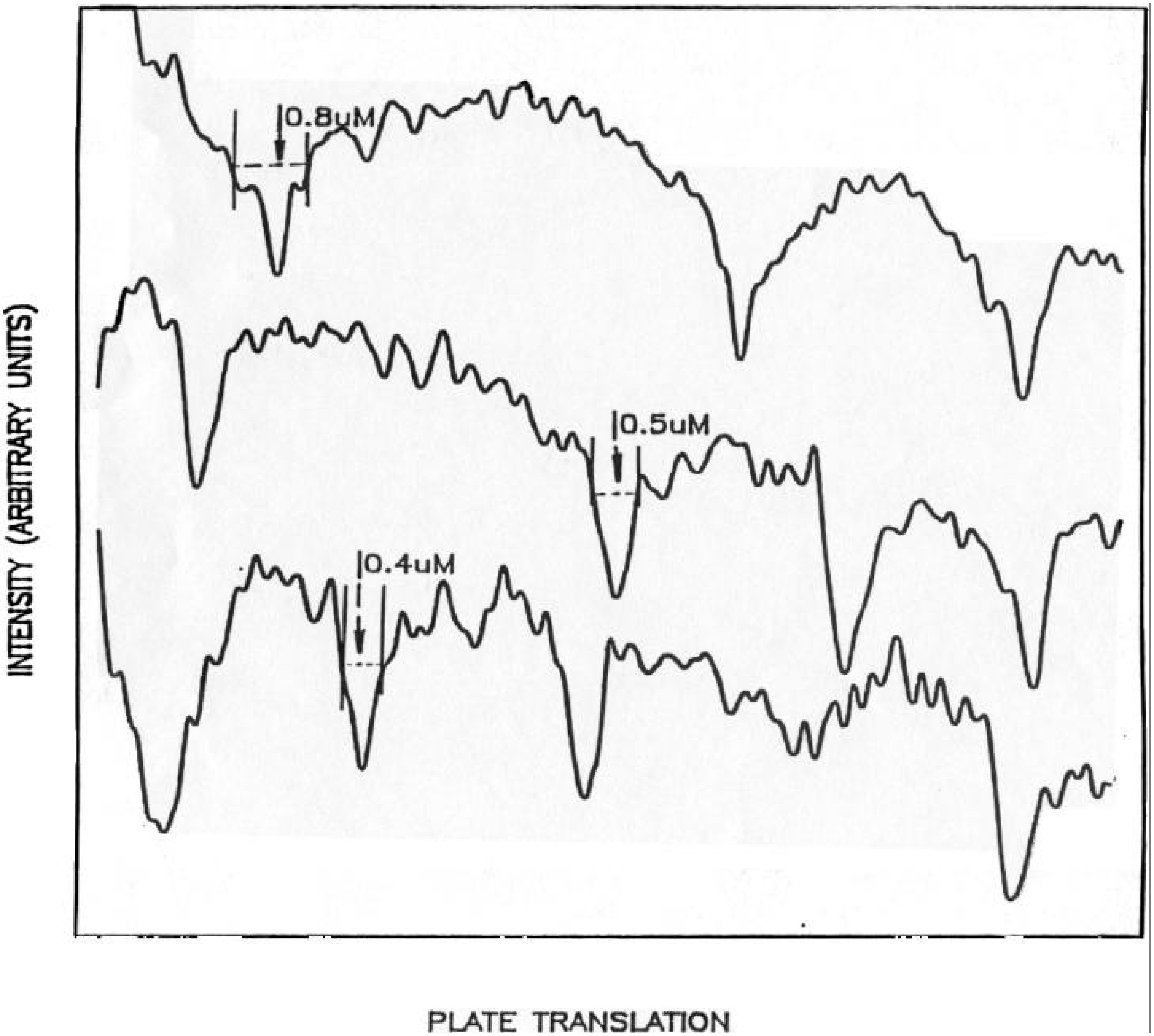
EXAMPLE OF SERODS READ-OUT PROCESS
(KRYPTON LASER - 647.1 NM)

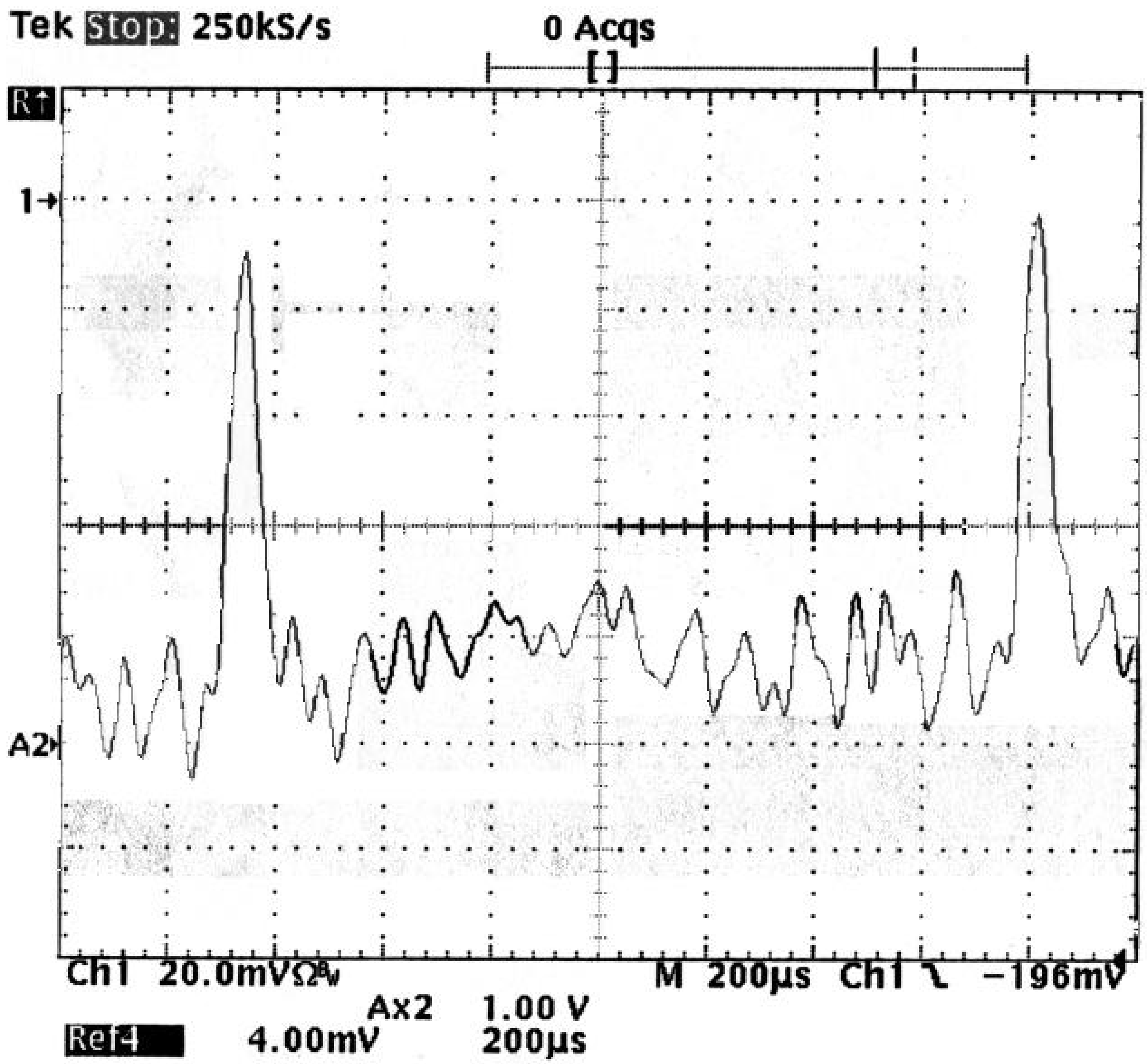
SERODS SETUP



SERODS Reading System




0.8uM
0.5uM
0.4uM
INTENSITY (ARBITRARY UNITS)
PLATE TRANSLATION



SERODS

Recording Laser Parameters:

Recording λ :	647.1nm
Recording Power:	190 mW
Translation Speed:	1 mm/s

Read Laser Parameters:

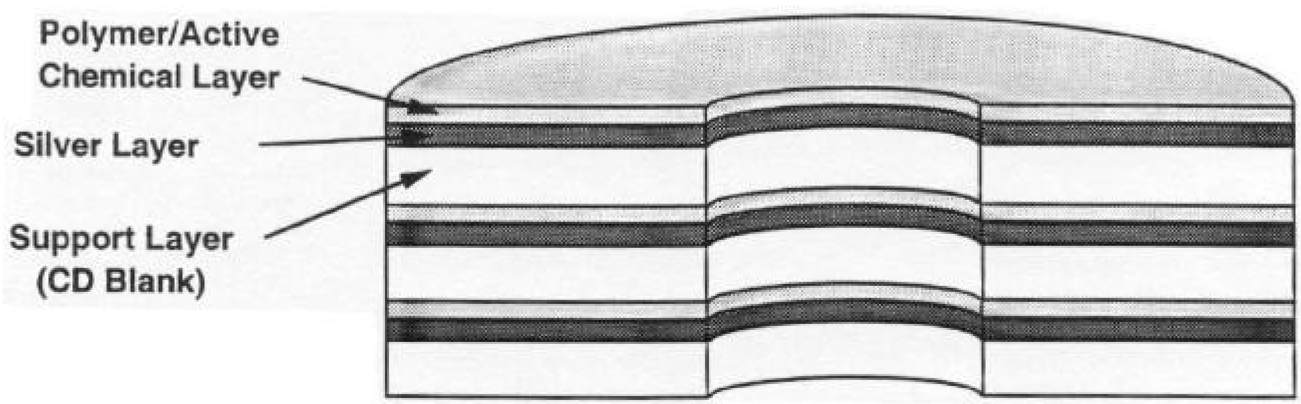
Read λ:	632.8 nm
Read Power:	5 mW

20 Revolutions Averaged

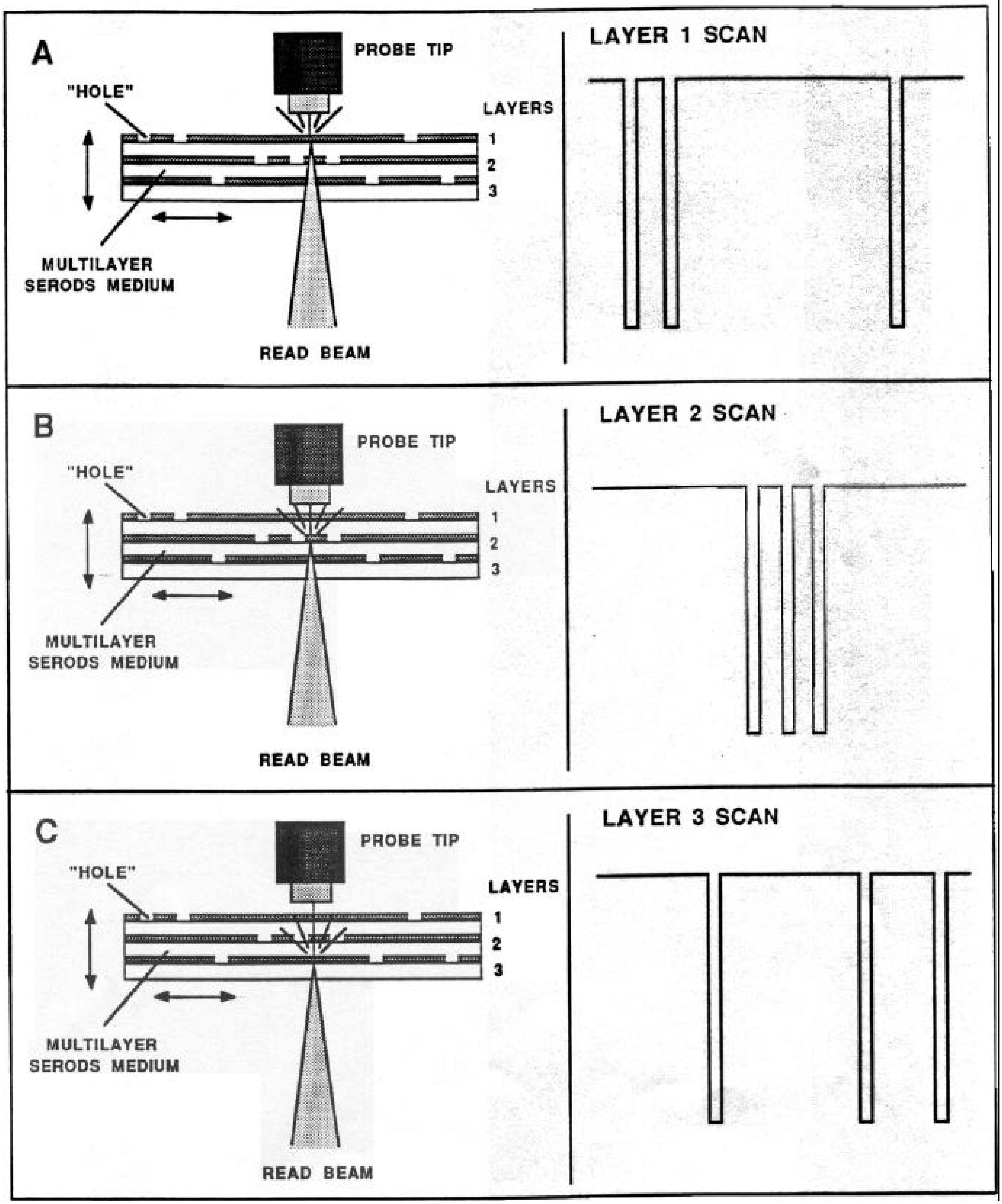
SERODS Medium:

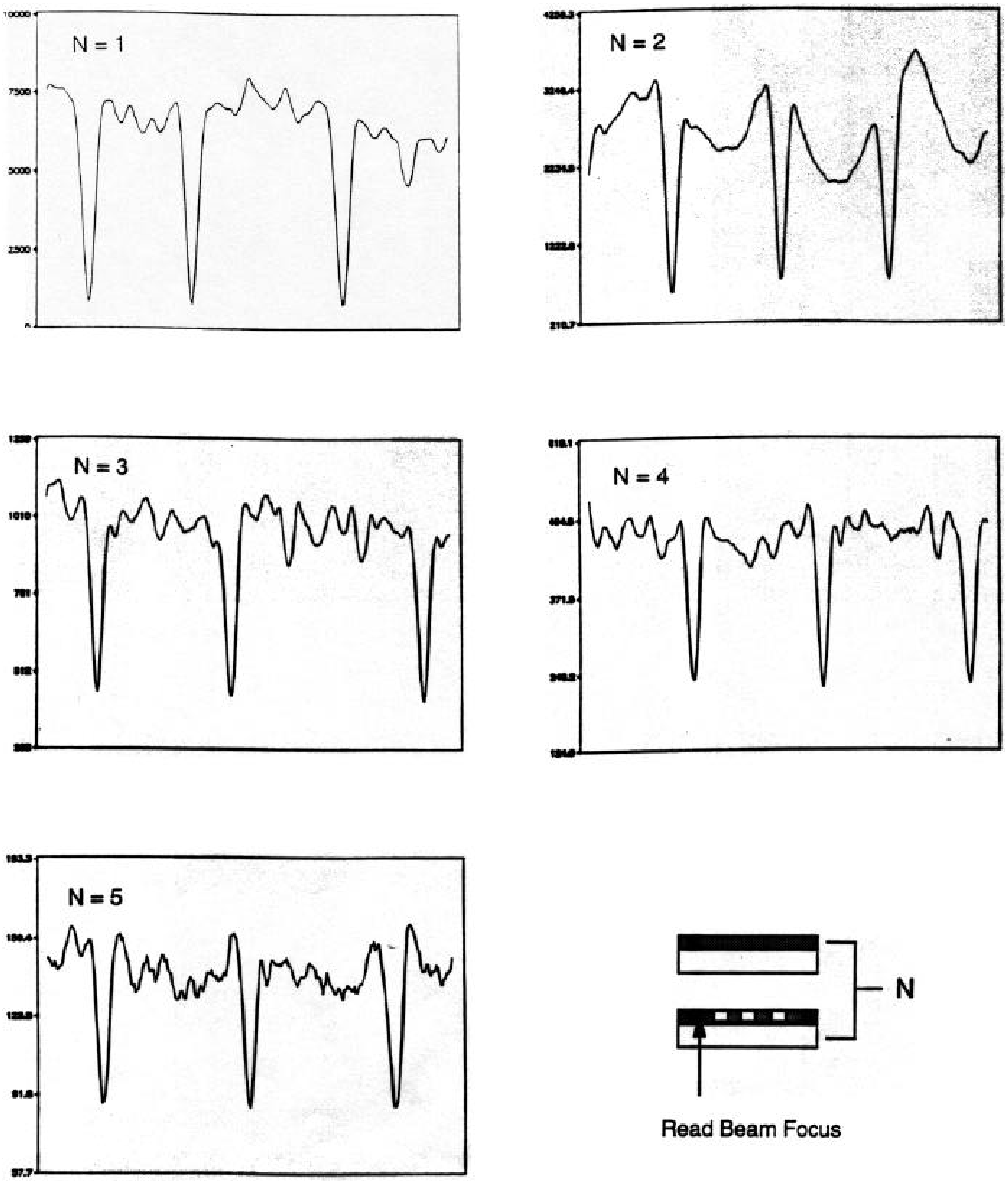
Alumina-based substrate
Cresyl Fast Violet (250 ppm)

Cross Section of a SERODS Disk



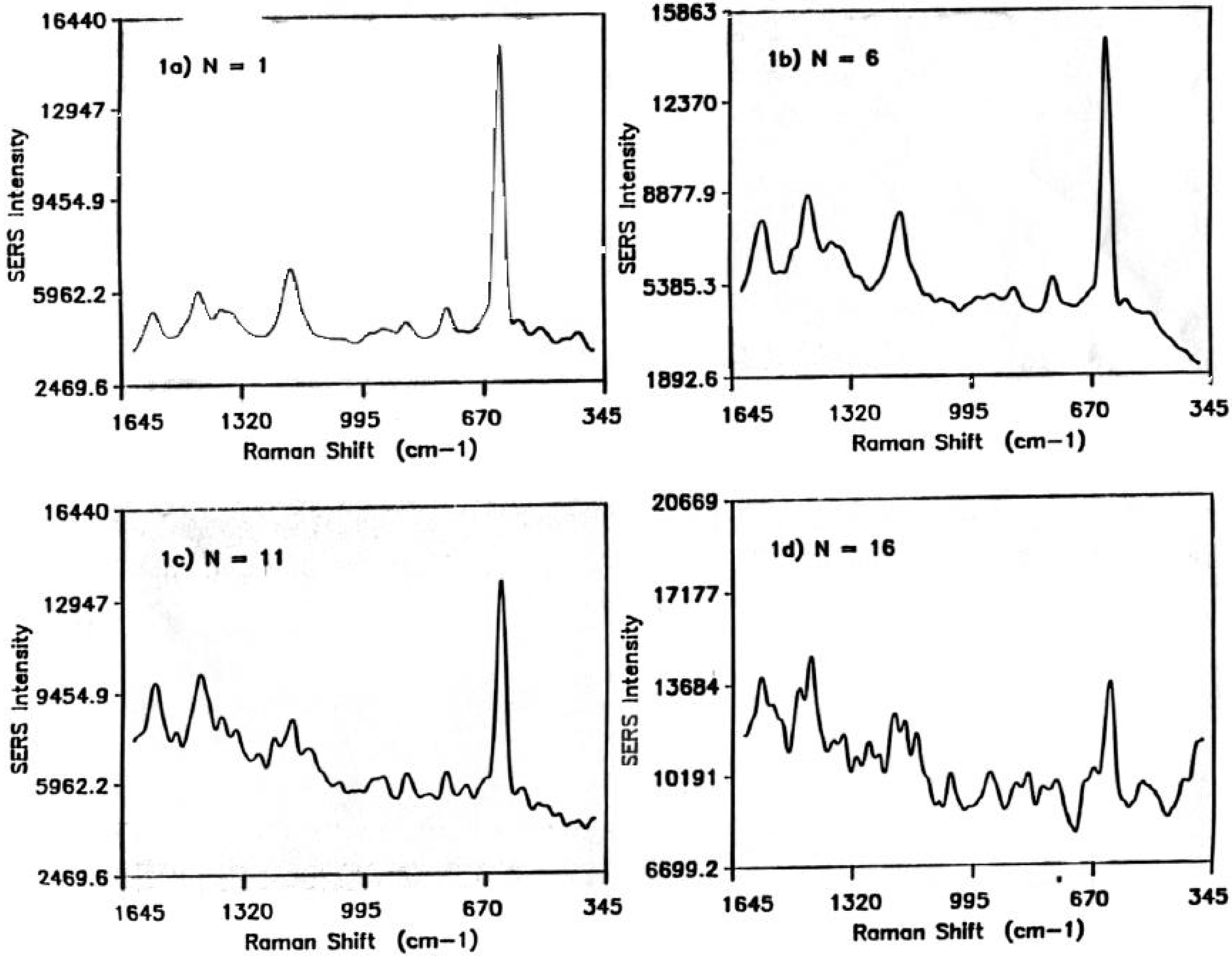
THREE-DIMENSIONAL SERODS CONCEPT





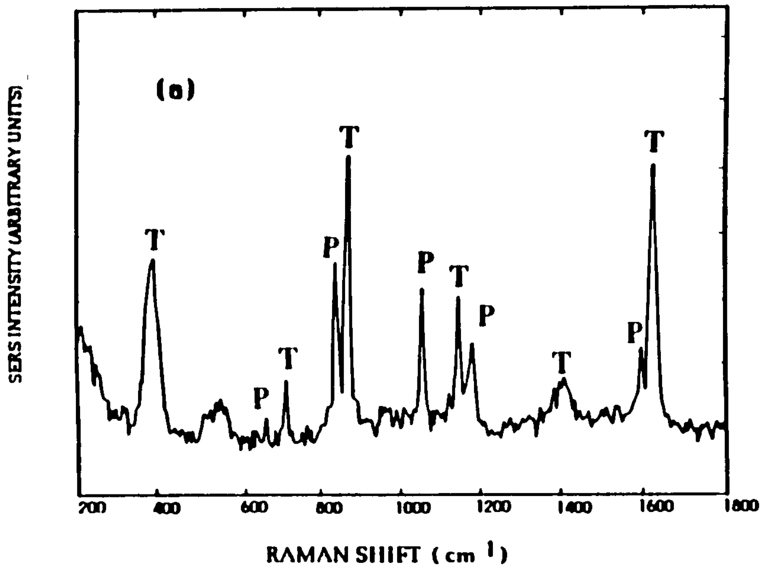
SERODS Pattern Read Through Multiple Layers

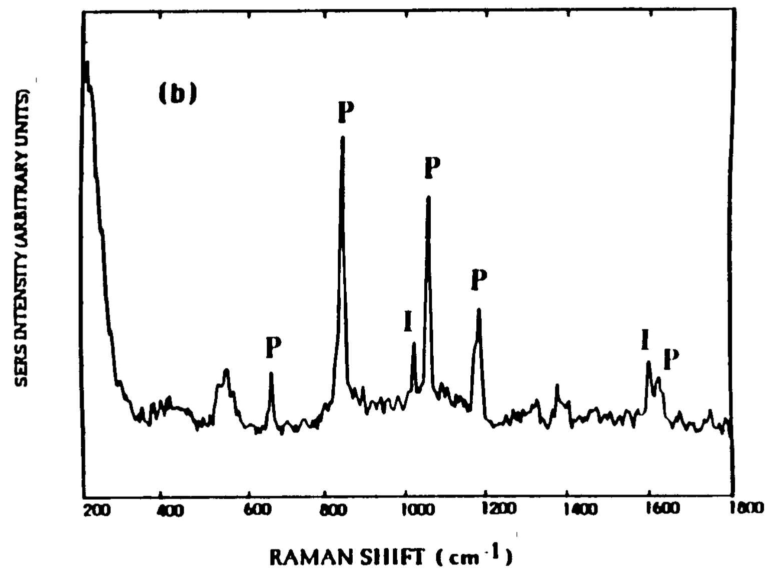
SERS Signal of BCB Detected through Multiple BCB-Spotted Silver Layers

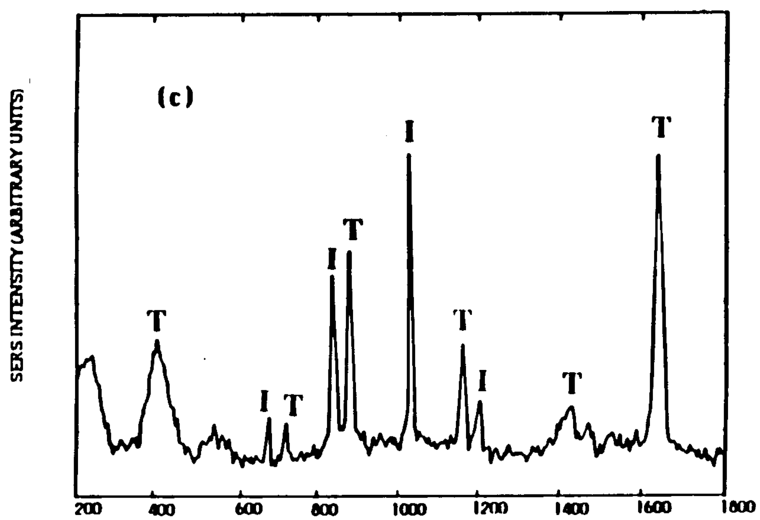


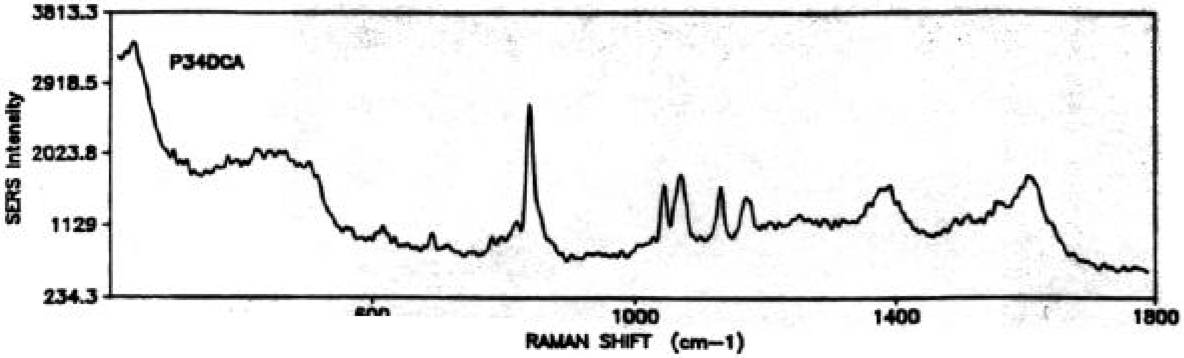
Multiplex Data Transfer

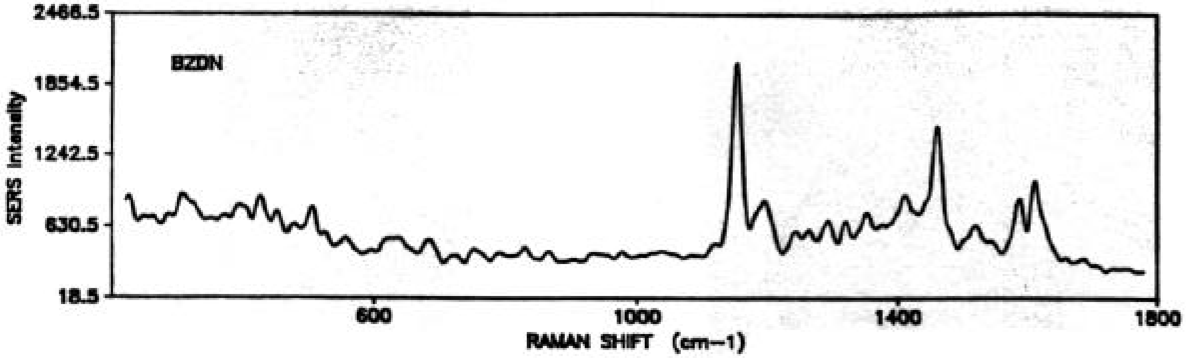
SERODS Technology Allows Multi-layer Disks Using Different Chemical Coatings

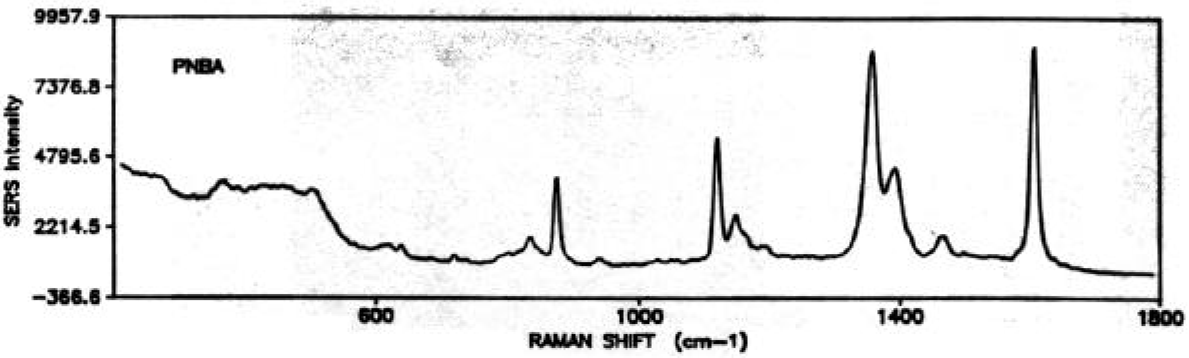


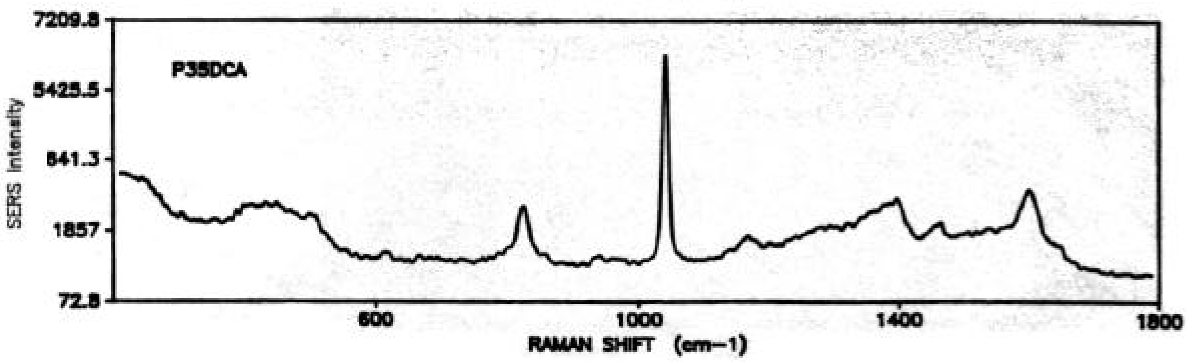


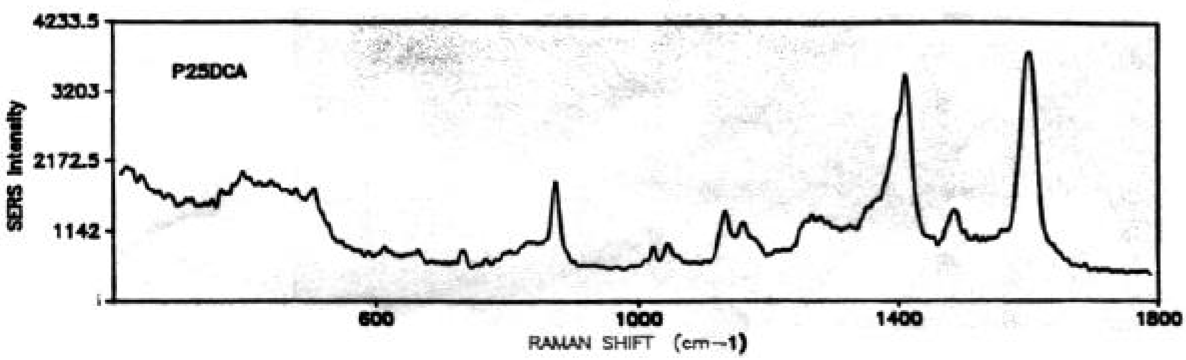



P34DCA
SERS Intensity
3813.3
2918.5
2023.8
1129
234.3
600
1000
1400
1800
RAMAN SHIFT (cm-1)


BZDN
SERS Intensity
2466.5
1854.5
1242.5
630.5
18.5
600
1000
1400
1800
RAMAN SHIFT (cm-1)


PNBA
SERS Intensity
9957.9
7376.8
4795.6
2214.5
-366.6
600
1000
1400
1800
RAMAN SHIFT (cm-1)


P35DCA
SERS Intensity
7209.8
5425.5
841.3
1857
72.8
600
1000
1400
1800
RAMAN SHIFT (cm-1)


P25DCA
SERS Intensity
4233.5
3203
2172.5
1142
600
1000
1400
1800
RAMAN SHIFT (cm-1)

CONCLUSION

ADVANTAGES AND POTENTIAL OF SERODS

* INCREASED STORAGE DENSITY
* SERODS HOLES AT DIFFRACTION LIMIT
* THREE-DIMENSIONAL STORAGE
* NON-BINARY READING CAPABILITY
* MULTIPLEX DATA STORAGE
* PARALLEL PAGE TRANSFER
* REWRITABLE CONCEPT