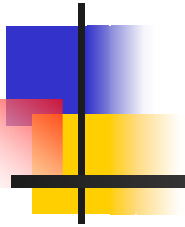


DIAMOND-LIKE CARBON



by

M.HELEN



OUTLINE

- Introduction
- Deposition Techniques
- Properties
- Applications
- References



What is DLC?

- Metastable amorphous hydrogenated carbon
- a-C:H 50 at. % hydrogen (DLC)
- a-C 1 at.% hydrogen (taC)

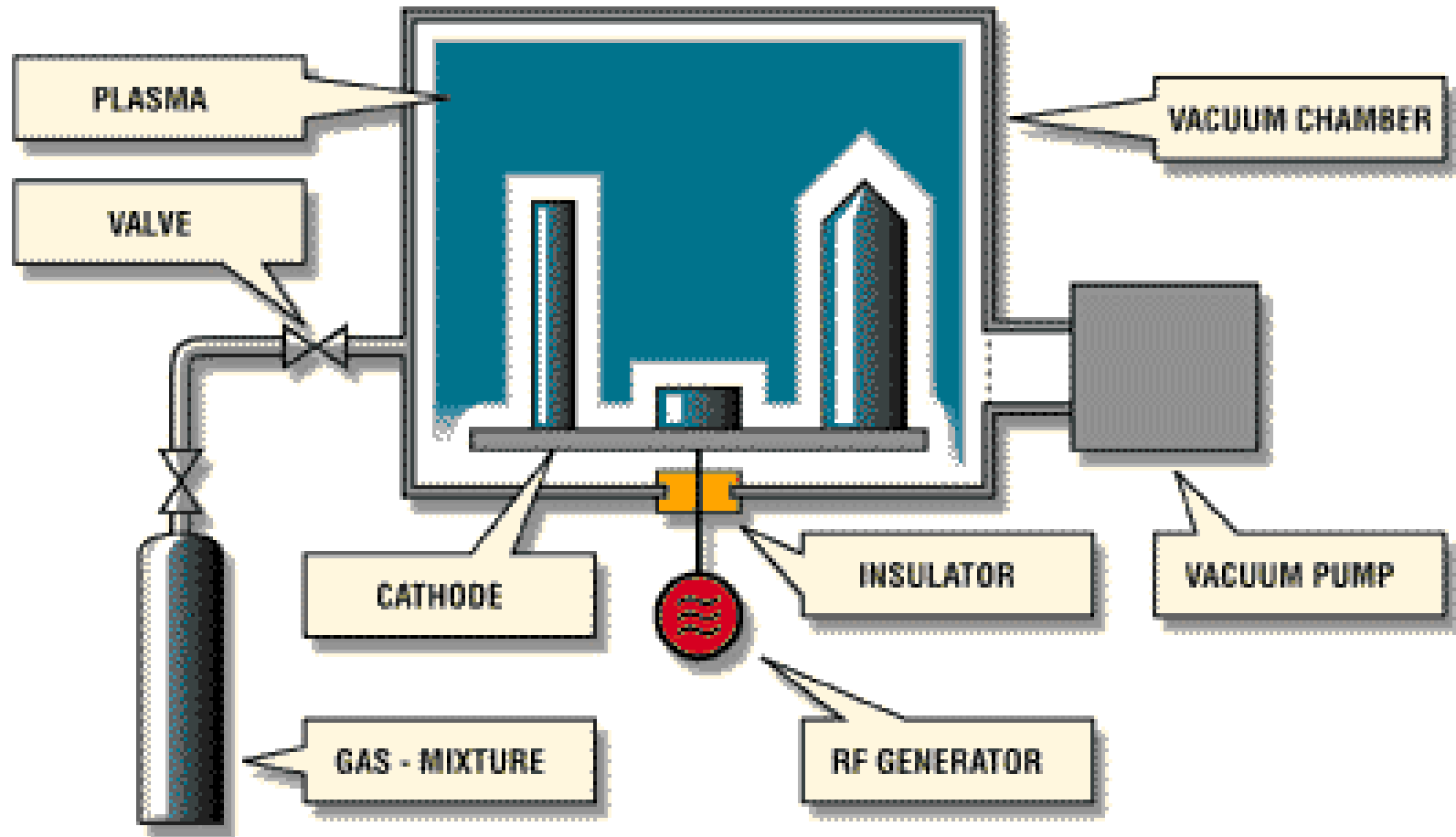
Aisenberg and Chabot (1971) by ion-beam deposition technique



Recent techniques for DLC deposition

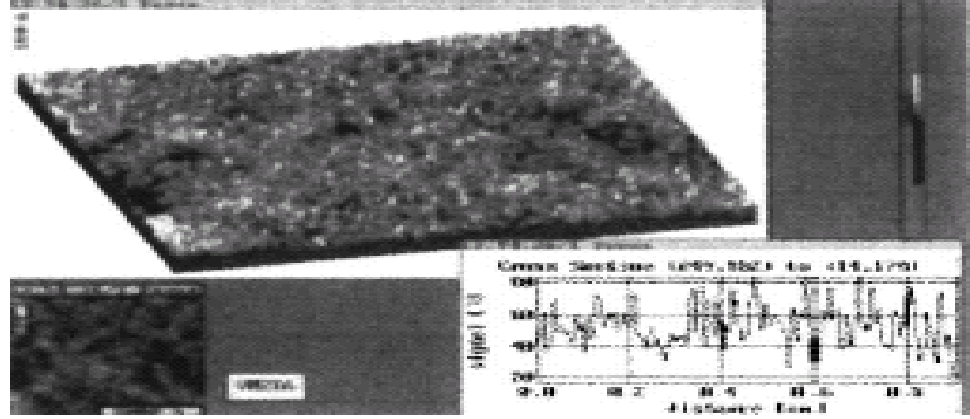
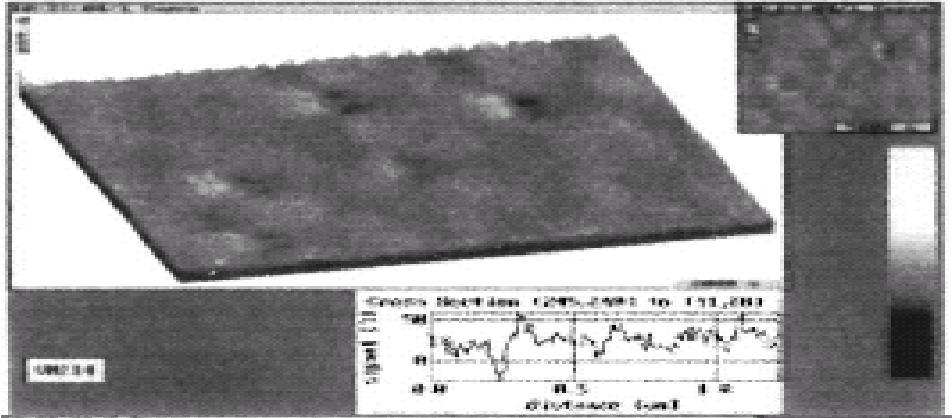
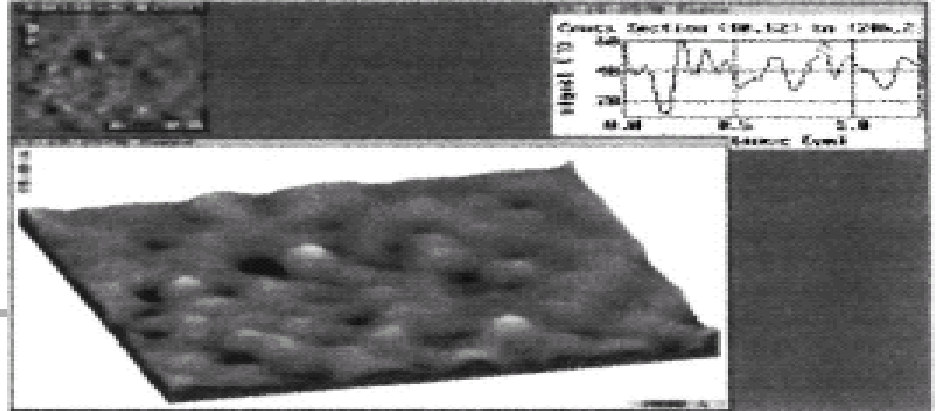
- Plasma Enhanced Chemical Vapour Deposition (PECVD)
- Plasma Source Ion Implantation (PSII)
- Bipolar pulsed DC PECVD

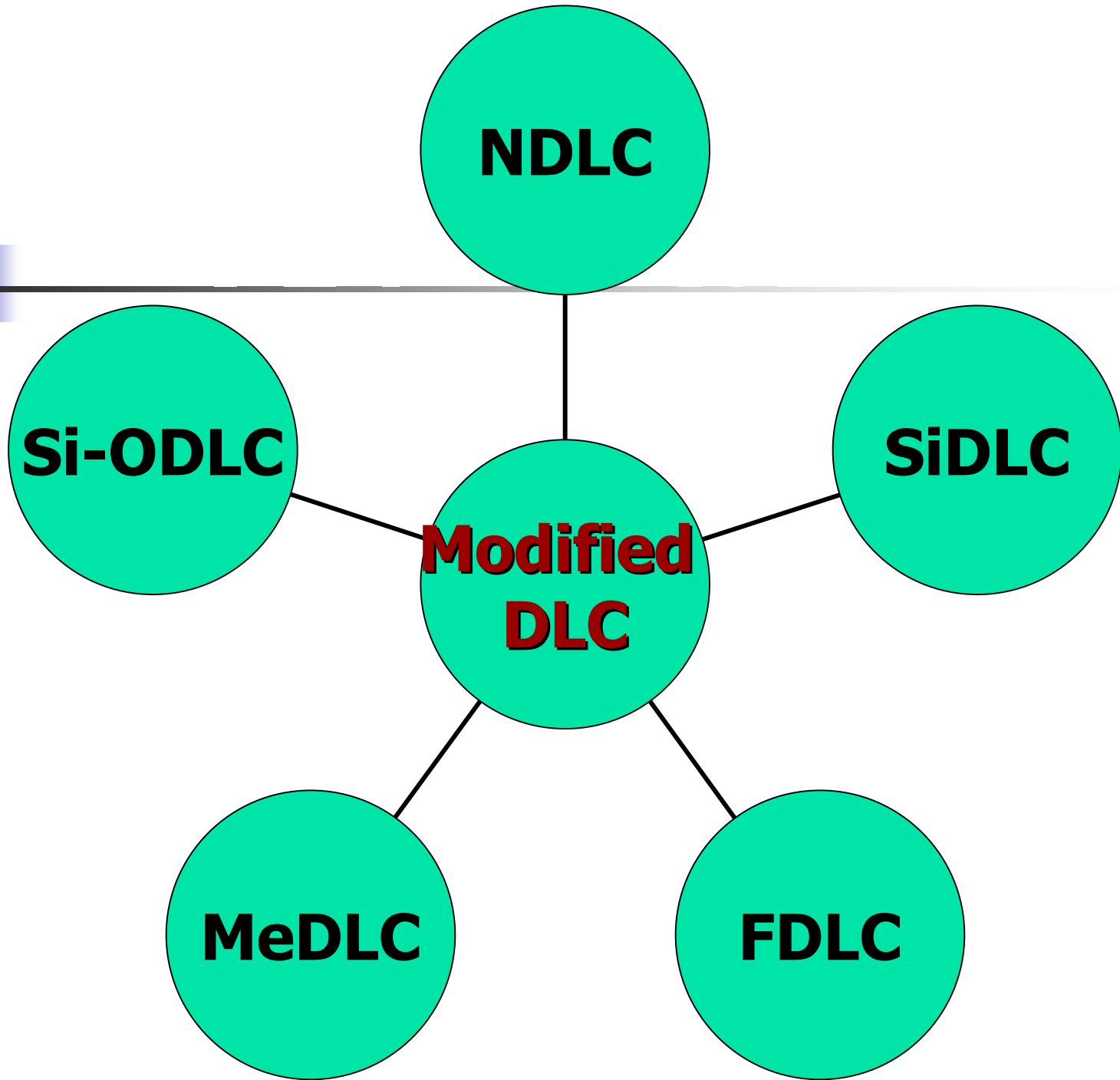
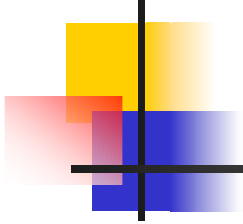
PACVD Coating Equipment



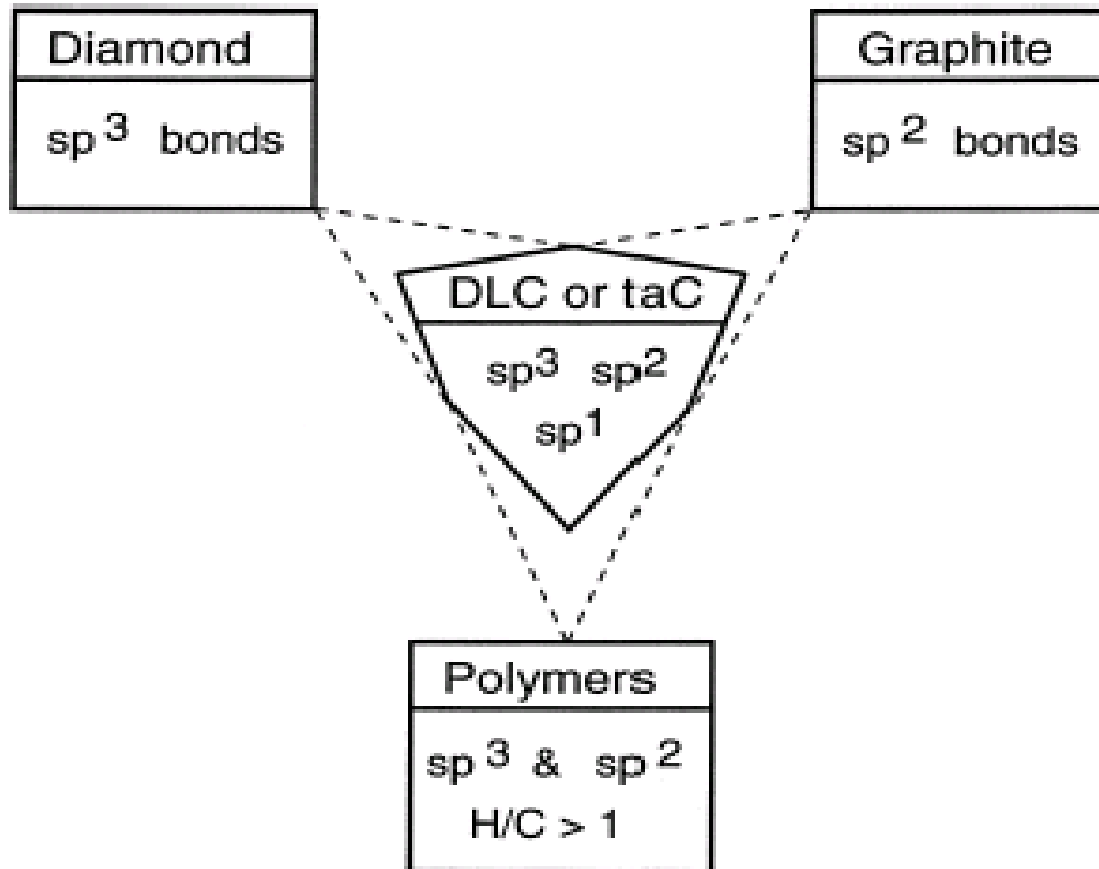


AFM images of films
produces at different
bias voltage
($V_b = -100, -300, -500$)





Properties of DLC





Structure of DLC

Angus and Jahnsen

- **3-D array of 6 membered rings with 17 - 61 at.% bonded hydrogen**

Robertson

- **π - bonding of sp^2 favors clustering of sp^2 sites**
- **Sixfold planar "aromatic" rings fuses into graphitic clusters**
- **$E_g = 6/M^{1/2}$ eV**
- **Distorted clusters controls the band gap**
- **Optical bandgap decreases with increasing sp^2 fraction**



Characterization

- **NMR** - C hybridization
- **FTIR** - C hybridization and Hydrogen content
- **Raman Spectroscopy** – 1332 cm^{-1}
- **RBS** – Film composition
- **FRES** - Hydrogen concentration
- **Young's modulus** – Mechanical properties



Mechanical Properties

Hardness : 10 – 30 GPa

Young's modulus : 6 – 10 times higher

Internal compressive stress : 0.5 – 7 GPa
(N, Si, O or metals)



Material Stability

Heat treatment : Loss of hydrogen & CH_x species

UV irradiation : Oxidation of C-C & C-H

Field Emission

20 nm NDLC coated Mo tip enhanced emission
current from 160 – 1520 μA



Tribology

- **Low friction coefficients and wear**

$\mu = 0.007- 0.4$ in vacuum

$\mu = 0.05 - 1.00$ in air

- **Controlled by interfacial transfer layer**

Low – k dielectrics

- **DLC** $k = 2.7-3.8$

- **FDLC** $k < 2.8$ (SiO₂ $k=4.0$)

- **Used as back end of the line (BEOL) interconnect for ULSI circuits**

Applications

- **Optical coatings**

Antireflecting and wear-resistenteant coatings for IR optics

- **Chemically passivating coatings**

Corrosion protection of magnetic media, biomedical

- **Tribological, wear-resistant coatings**

Magnetic hard drives, magnetic tapes, razor blades

- **Very-thin coatings <5 nm**

Magnetic media

- **Insulating coatings (Electrical resistivities = $10^2 - 10^{16} \Omega \text{ cm}^{-1}$)**

Insulating films

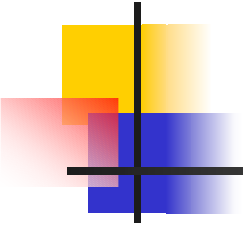
- **Field emission**

Field emission flat panel display

References



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THANK UUUUUUUU!