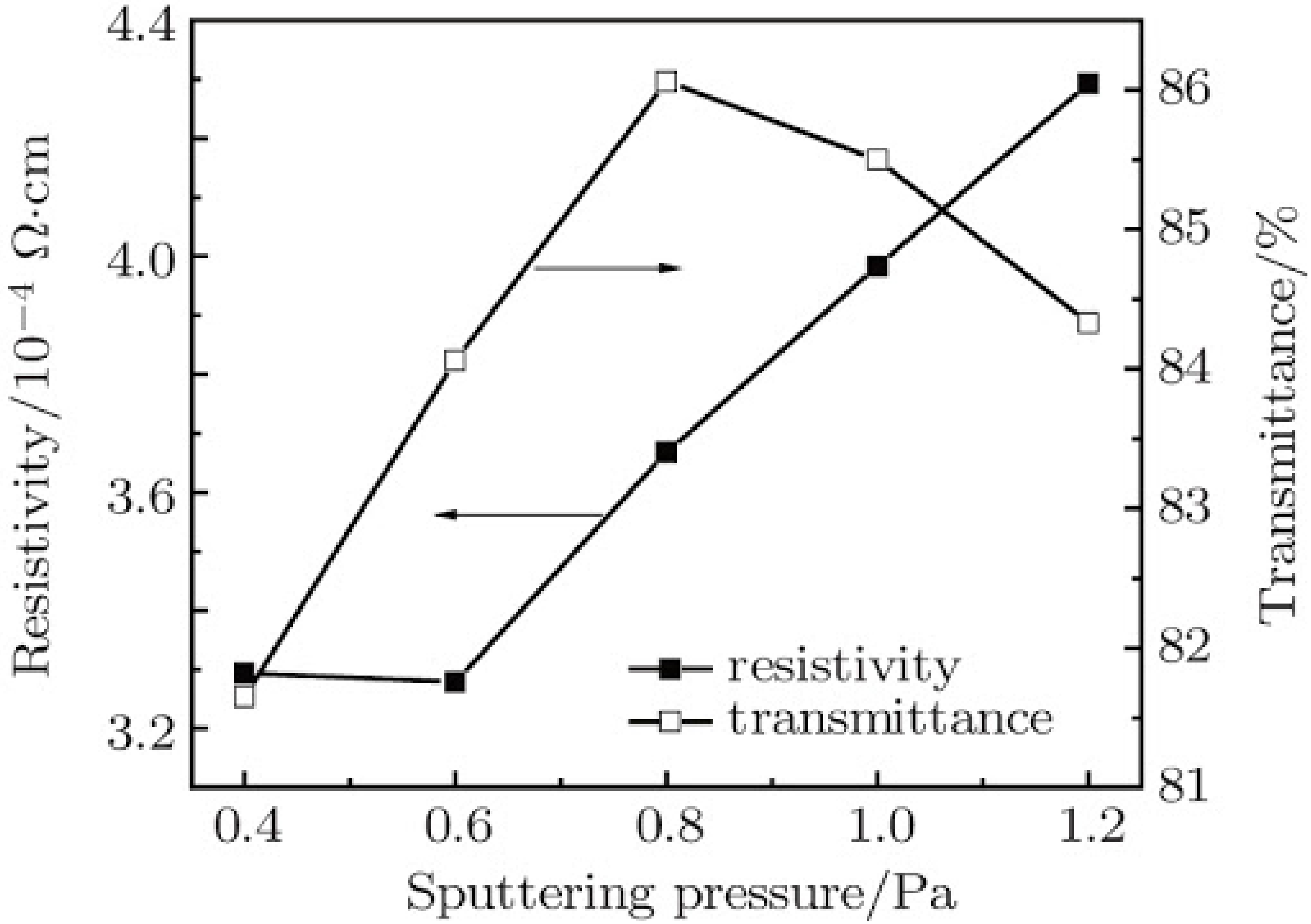
Effect of different deposition conditions on material properties for semiconductor device fabrication

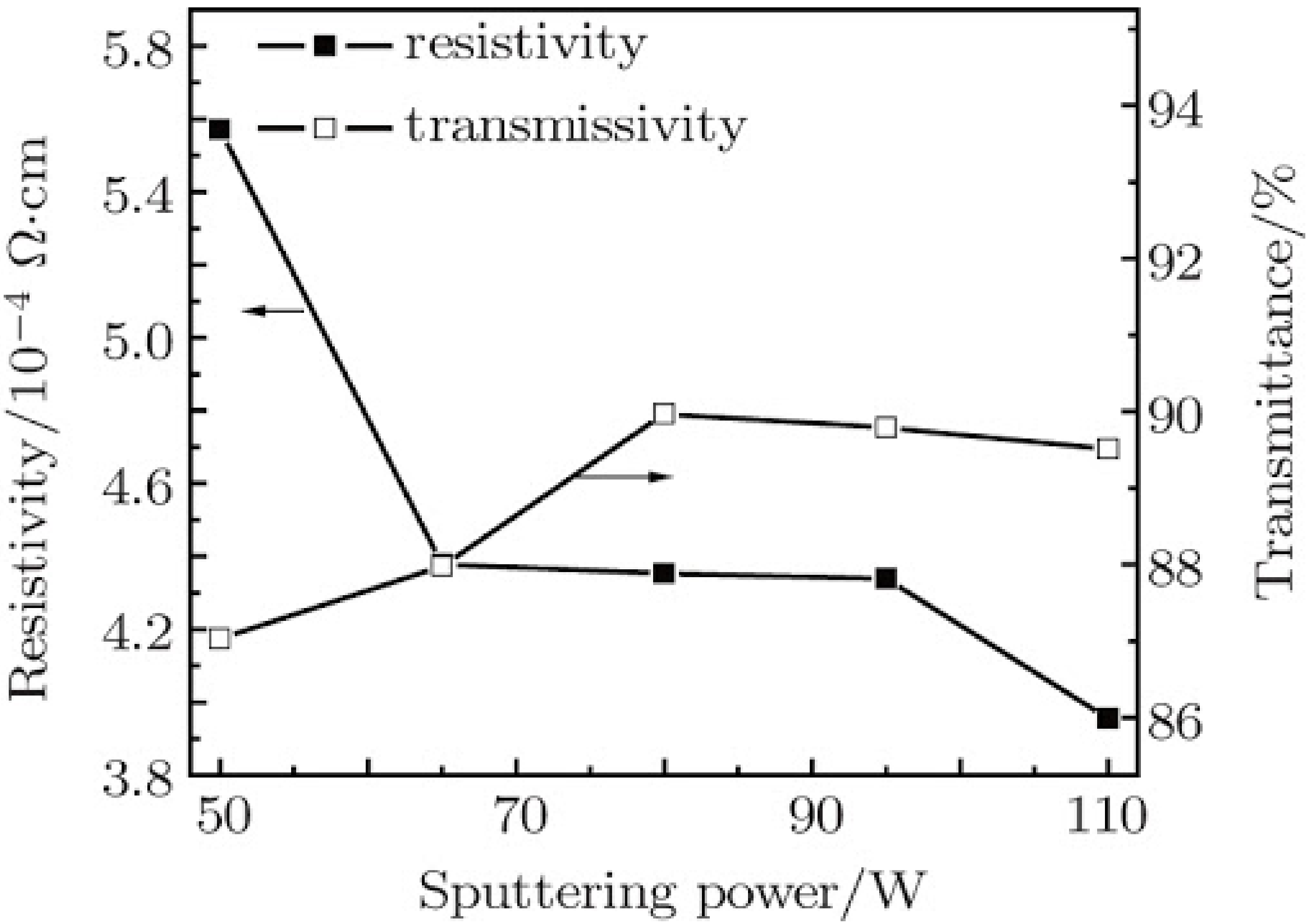
Controlling parameters for the deposition of ITO from RF Sputtering technique

- RF Power / Power Density (power density is more common term)
- Chamber Pressure during deposition
- Substrate Temperature
- Ratio of different gas flow (like Oxygen, Argon, Hydrogen etc.)
- Interelectrode distance

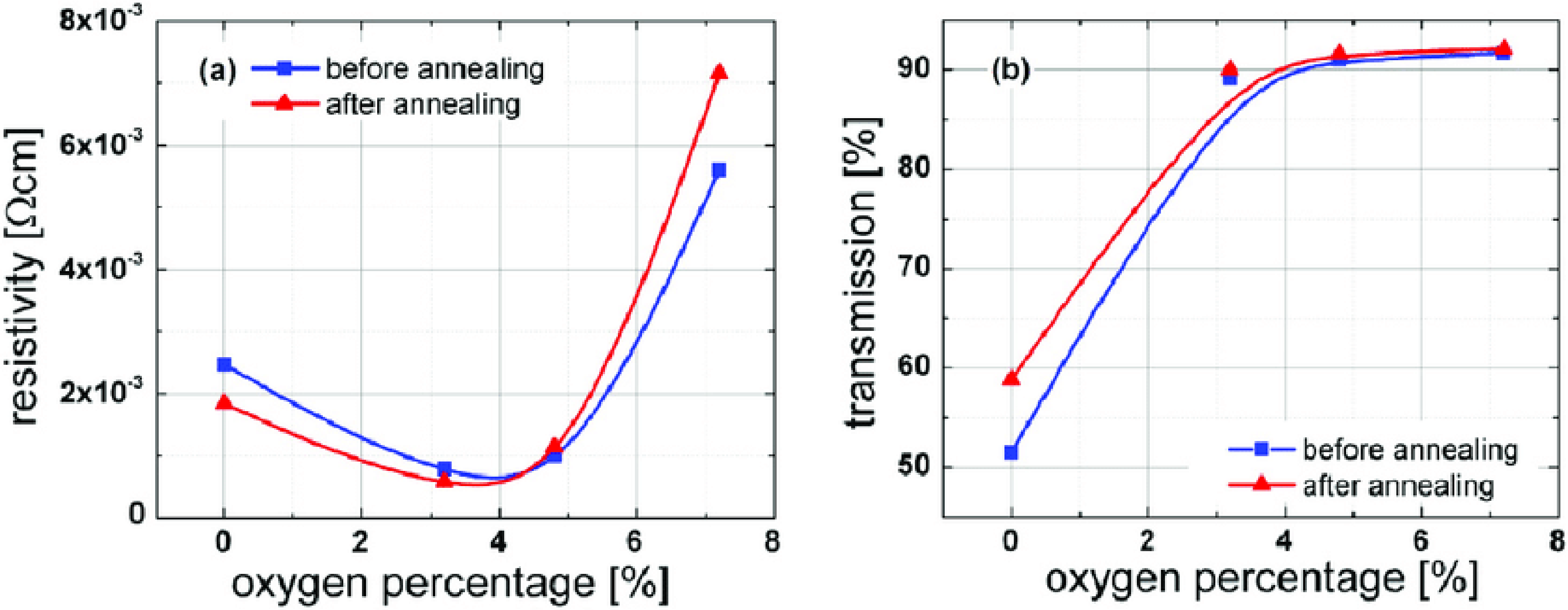
Variation of Resistivity and Transmittance with Pressure for ITO



Variation of Resistivity and Transmittance with Power for ITO



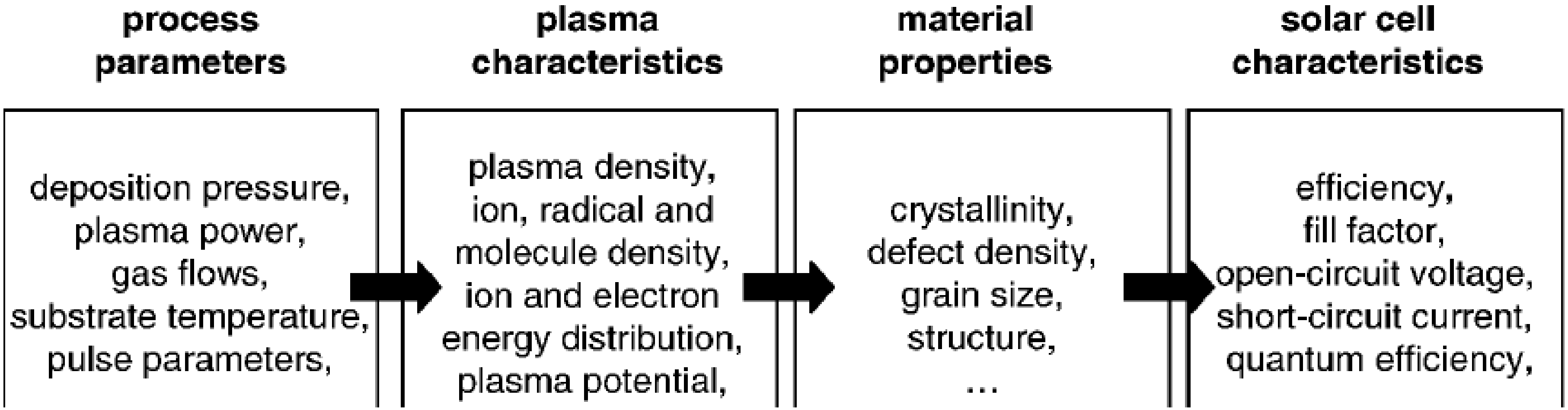
Variation of Resistivity and Transmittance with Oxygen % for ITO



Controlling parameters for the deposition of thin film silicon from PECVD

1. RF Power density
2. Gas flow ratio / percentage
3. Chamber pressure
4. Substrate temperature
5. Electrode distance
6. Electrode configuration

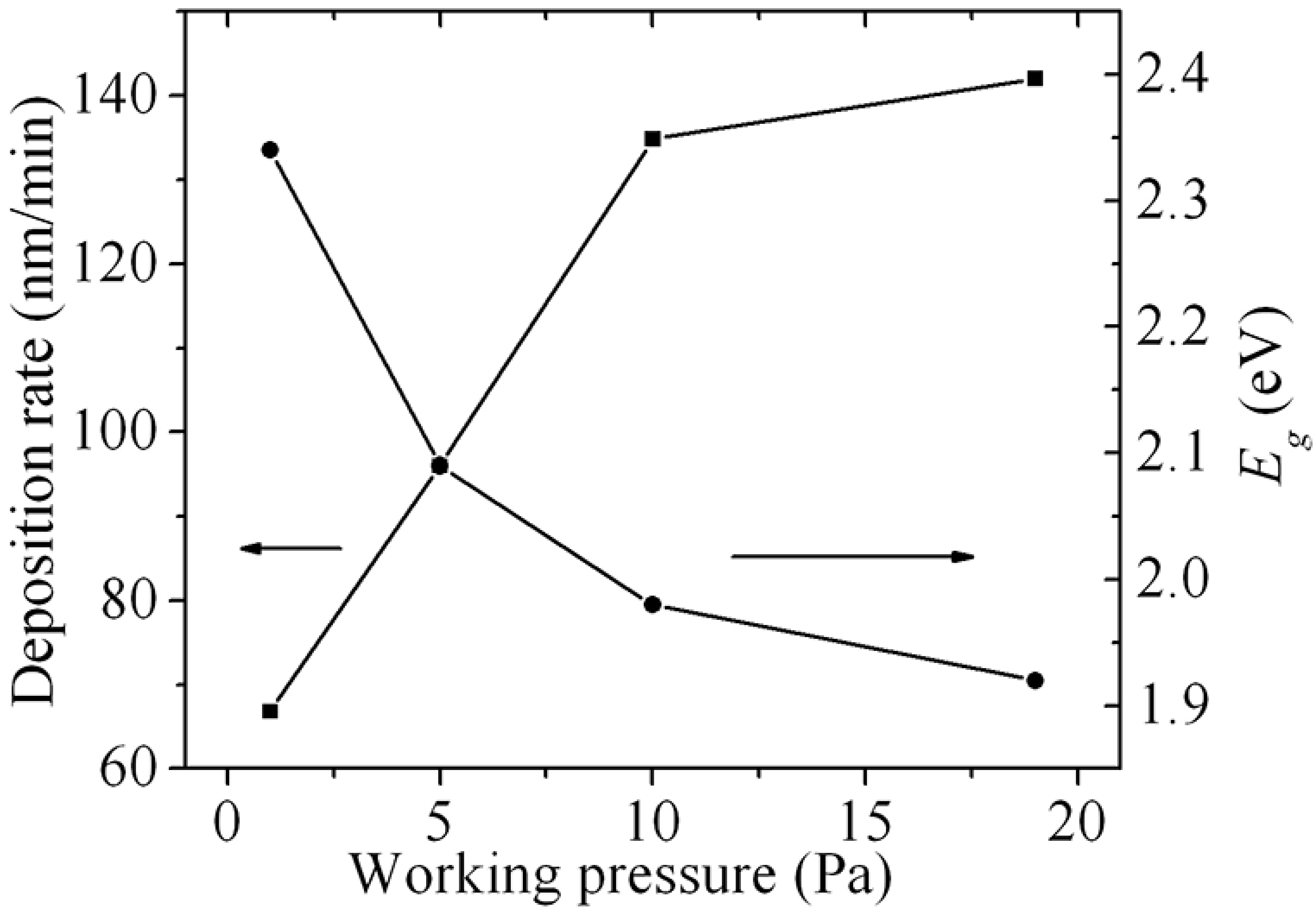
Link between plasma formation and the final semiconductor device



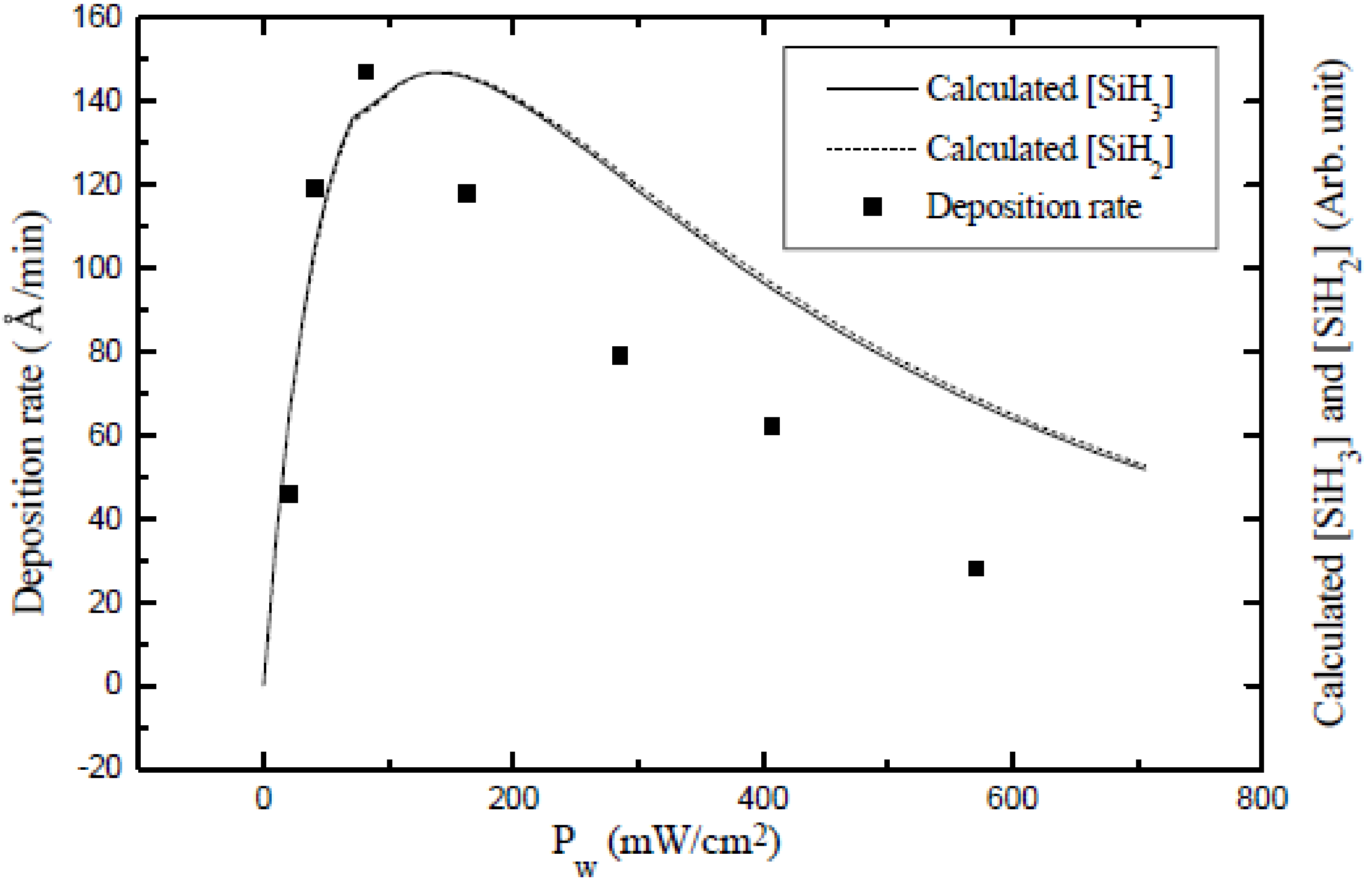
PECVD for the deposition of thin film silicon:

PECVD is a deposition method where reactive species are produced by an electrical discharge leading to a plasma . The gas-phase reactions in glow discharges reduce the substrate temperature required for film deposition compared to thermal CVD, which depends completely on thermally-induced gas-surface interaction. Major steps of the plasma-enhanced CVD process include source gas diffusion, electron impact dissociation, gas-phase chemical reaction, radical diffusion, and deposition. When silane (SiH_4) is used as a source gas in a glow discharge deposition process, the electron impact processes lead to reactive neutral species, such as SiH, SiH_2 , SiH_3, Si_2H_6 , H, and H_2 and ionized species, such as SiH+, SiH_2 , SiH_3 , and so on. The properties of the deposited silicon film and especially whether its structure is amorphous or microcrystalline strongly depend on the combination of the deposition parameters used.

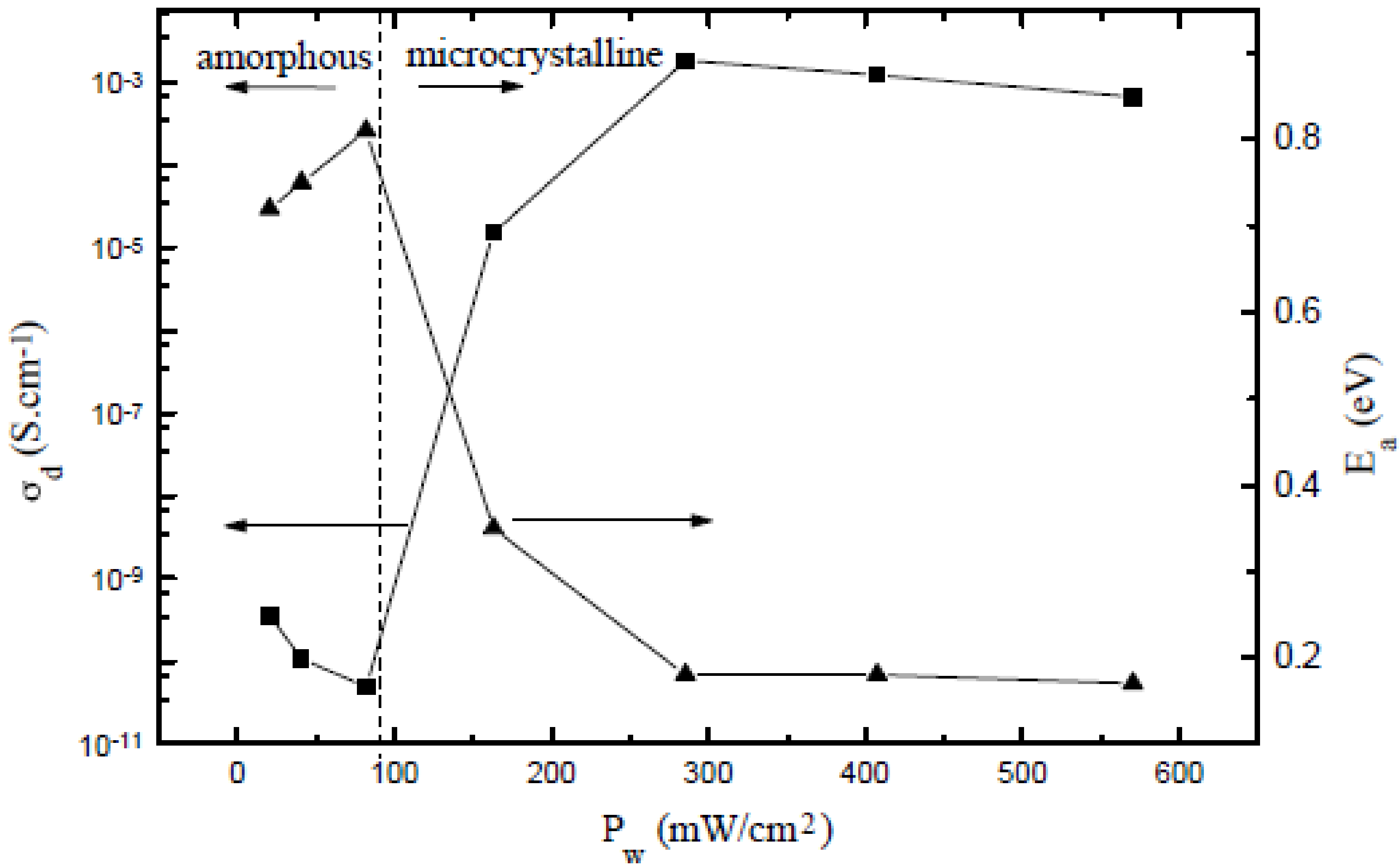
Effect of deposition parameters for the deposition of amorphous silicon by PECVD



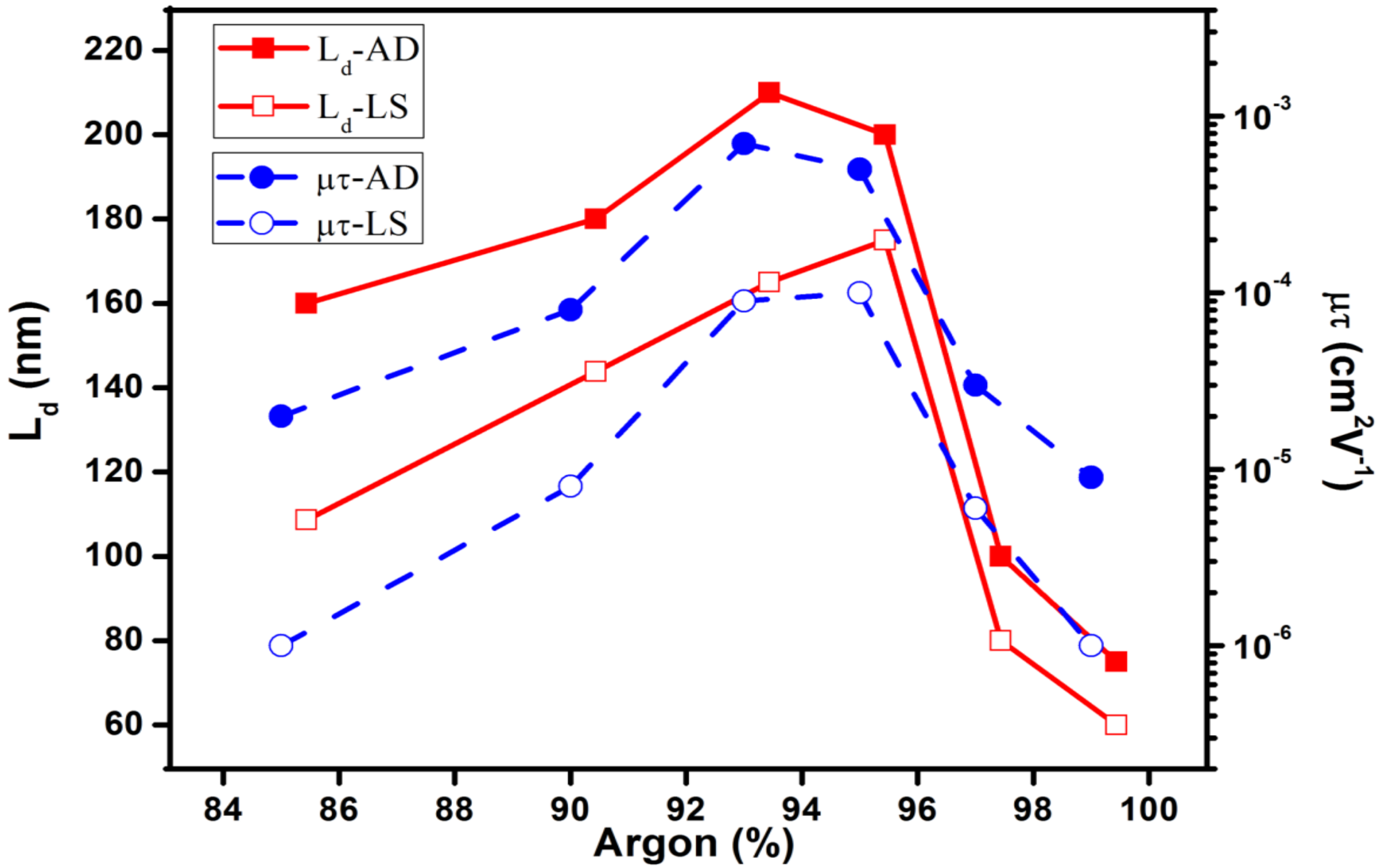
Effect of power density on Silicon deposition rate for PECVD



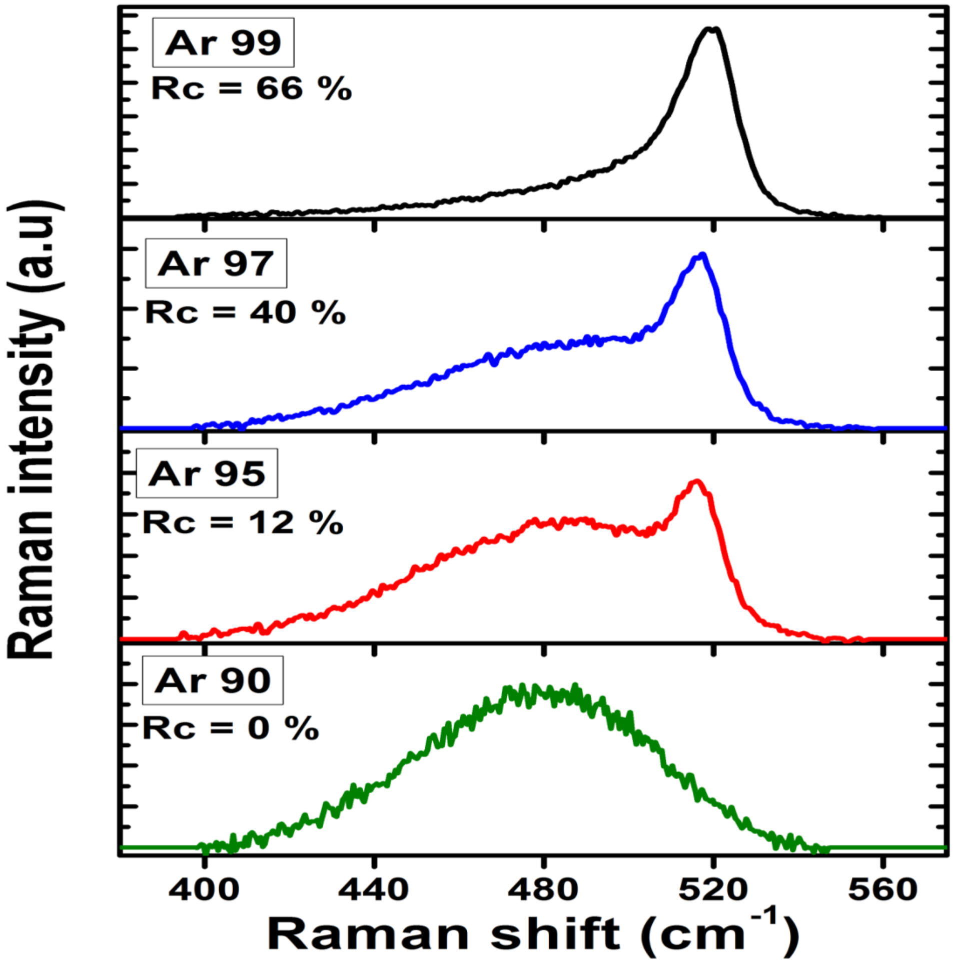
Variation in material property with the variation of RF power



Variation of Diffusion length (L_d) and mobility-lifetime ($\mu\tau$) product f silicon thin film for application in solar cell



Raman study of thin film silicon deposited by PECVD

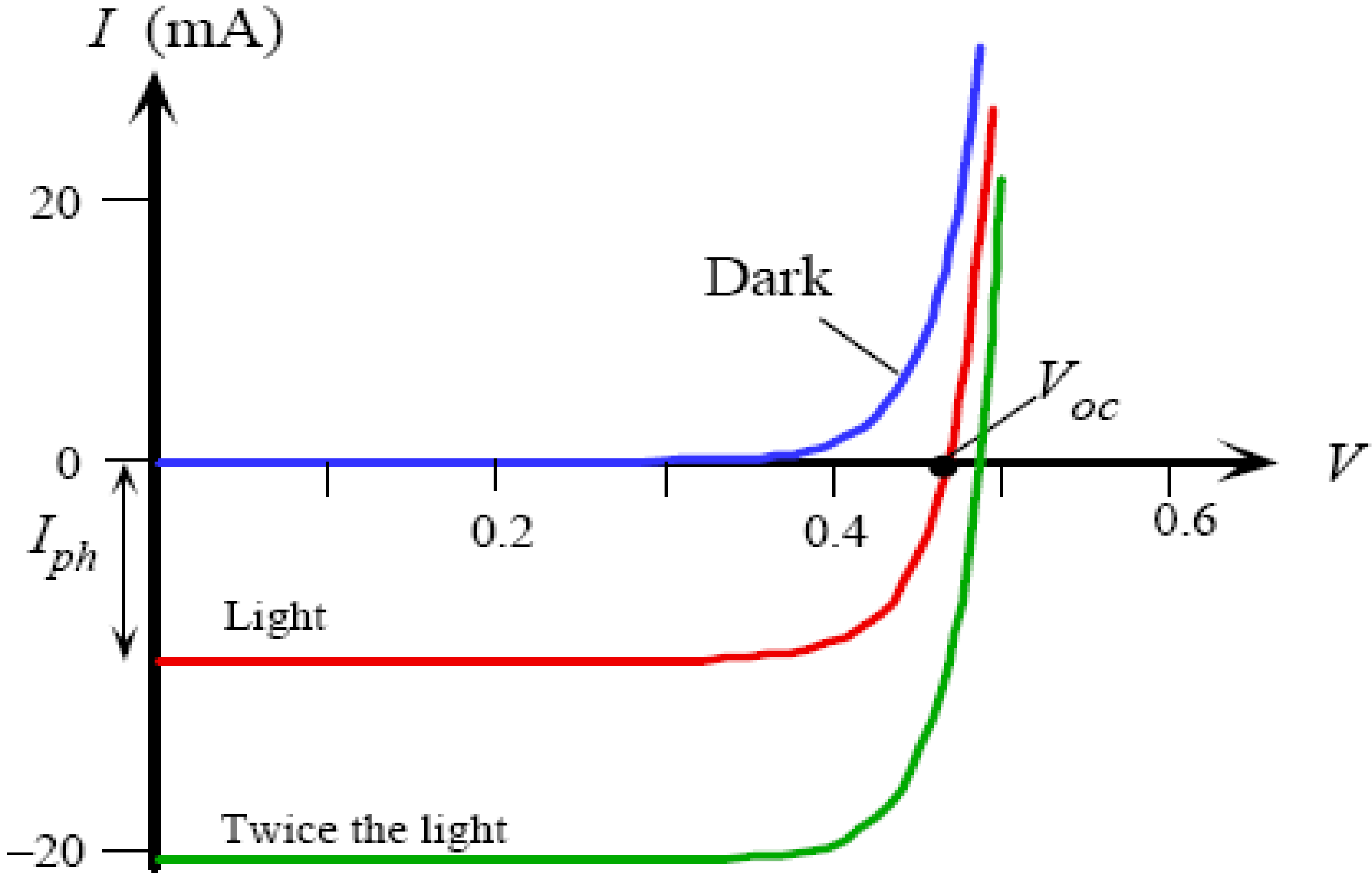


- As we increase Argon dilution, crystalline fraction increases and material changes from amorphous to nanocrystalline to microcrystalline phase.

MATERIAL PROPERTIES

Silane (Sccm)	Argon (Sccm)	Sample Name	Activation Energy (eV)	Crystalline fraction (%)
1	99	Ar99	0.2	66
3	97	Ar97	0.4	40
5	95	Ar95	0.78	12
7	93	Ar93	0.85	9
10	90	Ar90	0.85	0
15	85	Ar85	0.88	0

Photovoltaic I-V Characteristics



The fill factor (FF) of a p-i-n cell is defined by

$$FF = \frac{I_m V_m}{I_{sc} V_{oc}}$$

The conversion efficiency of a solar (Photovoltaic) cell is defined by the ratio of the maximum power output (Pout) to incident power of illumination (Pin)

$$h = \frac{P_{out}}{P_{in}} \times 100\ \%$$

$$= \frac{I_m V_m}{P_{in}} \times 100\ \%$$

$$= \frac{FF.I_{sc} V_{oc}}{P_{in}} \times 100\ \%$$

Properties of amorphous silicon and corresponding solar cell efficiency – power density variation