



HAL
open science

Comparison of DC and RF Sputtering of ZnSnN₂: Effect on Structural, Optical and Electrical Properties

Ngoc Kim Thanh Bui, Mathieu Halbwx, Jean-Pierre Vilcot

► **To cite this version:**

Ngoc Kim Thanh Bui, Mathieu Halbwx, Jean-Pierre Vilcot. Comparison of DC and RF Sputtering of ZnSnN₂: Effect on Structural, Optical and Electrical Properties. Journées Nationales du PhotoVoltaïque, Fédération de recherche du PhotoVoltaïque, FedPV, Jan 2021, Dourdan, France. hal-03257281

HAL Id: hal-03257281

<https://hal.science/hal-03257281>

Submitted on 10 Jun 2021

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

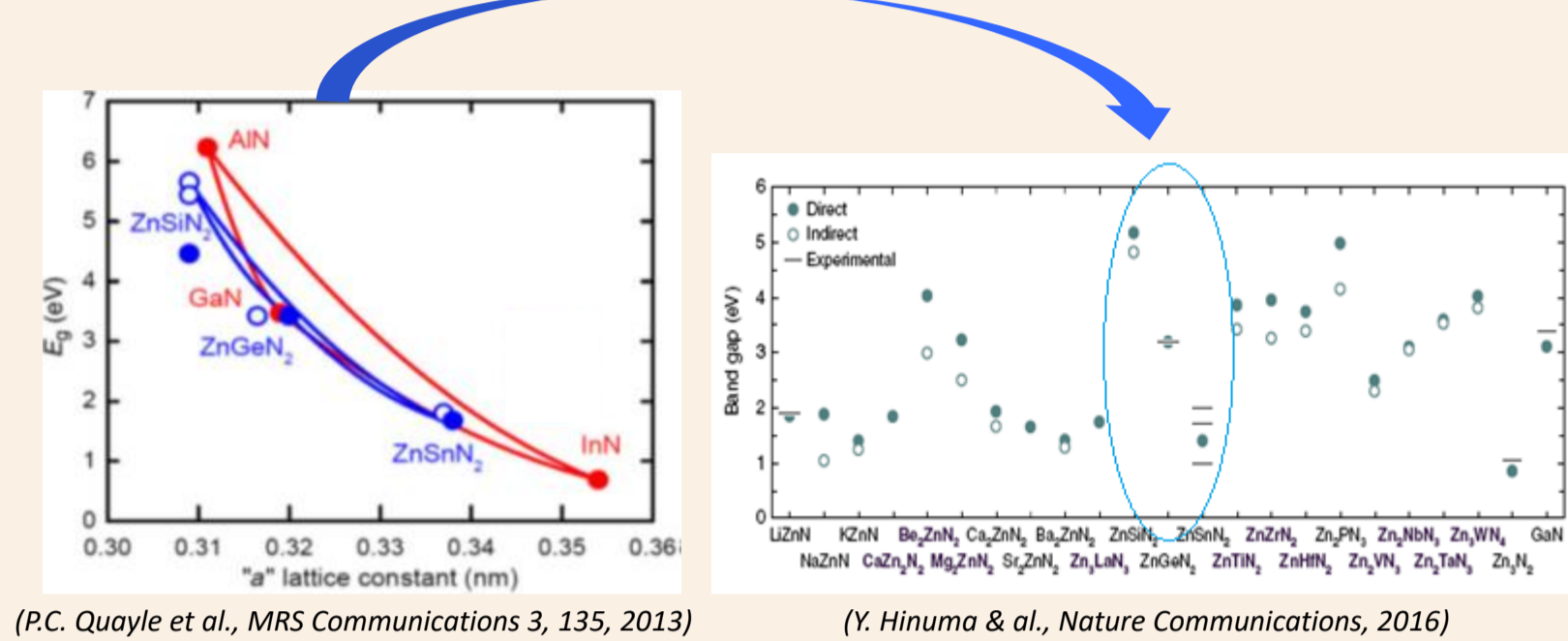
Comparison of DC and RF Sputtering of ZnSnN₂: Effect on Structural, Optical and Electrical Properties

T. N. K. Bui, M. Halbwx, and J. P. Vilcot

Univ. Lille, CNRS, Centrale Lille, Univ. Polytechnique Hauts-de-France, UMR 8520 - IEMN - Institut d'Electronique de Microelectronique et de Nanotechnologie, F-59000 Lille

Context

- ZnSnN₂ is a member of ternary Zn-IV-N₂ semiconductors:
- Low cost and non-toxic raw materials
 - Expected direct bandgap is approximate 1.7eV
 - Crystal structure, ground-state structural properties and phonon related quantities look close to those of III-N.



(P.C. Quayle et al., MRS Communications 3, 135, 2013) (Y. Hinuma & al., Nature Communications, 2016)

Our best result



Photoconductor structure

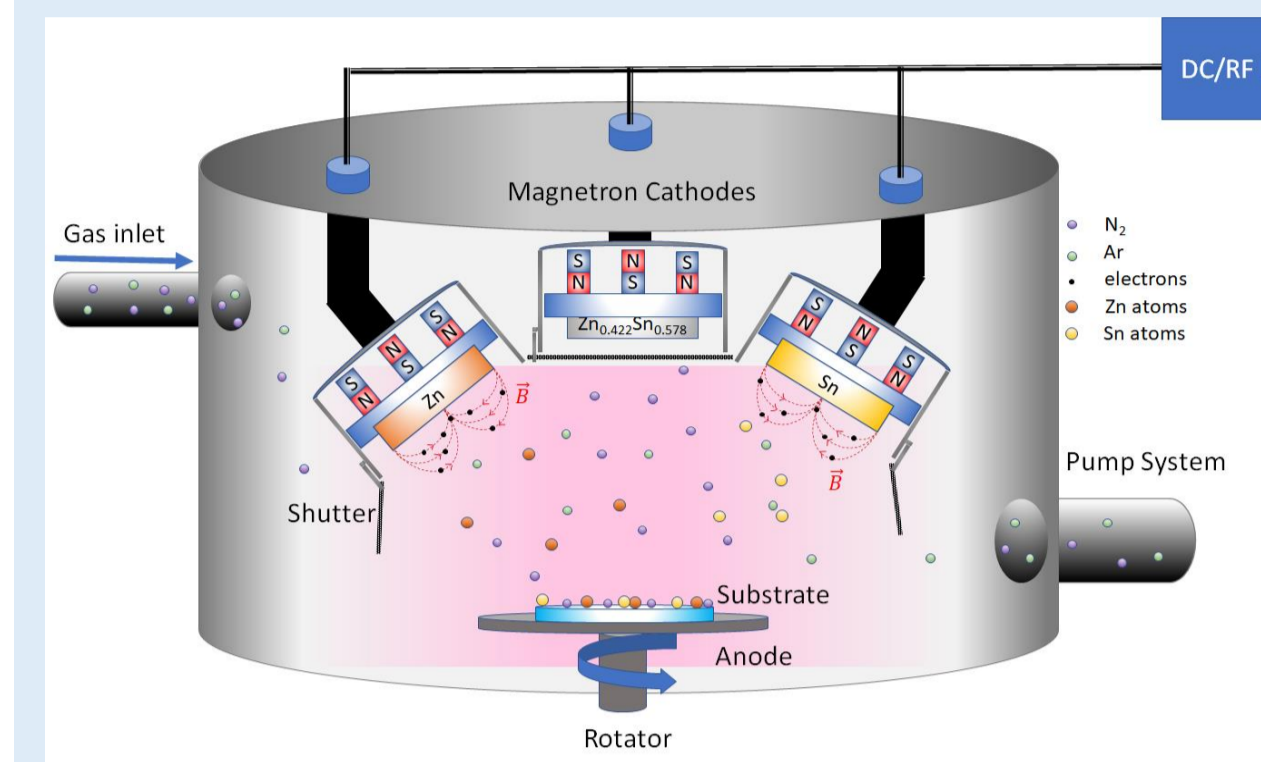
Probe position

→ Photocurrent density 150 mA.cm² (@0.5V bias and 1 Sun)

Zn_{0.46}Sn_{0.54}N_x (DC - RF Mode)
 $R = 0.28 \Omega \cdot \text{cm}$
 $\mu = 0.15 \text{ cm}^2 \cdot \text{V}^{-1} \cdot \text{s}^{-1}$ → small value
 $n = -1.5 \times 10^{20} \text{ cm}^{-3}$

Methods

Sputtering chamber Alliance Concept CT200

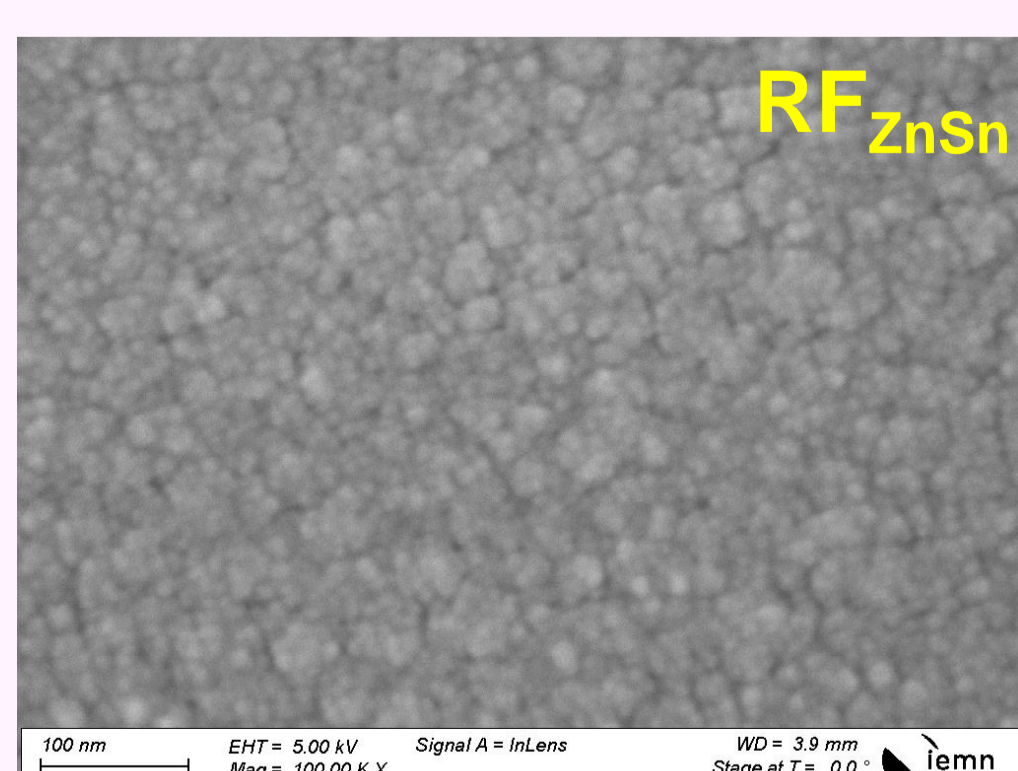
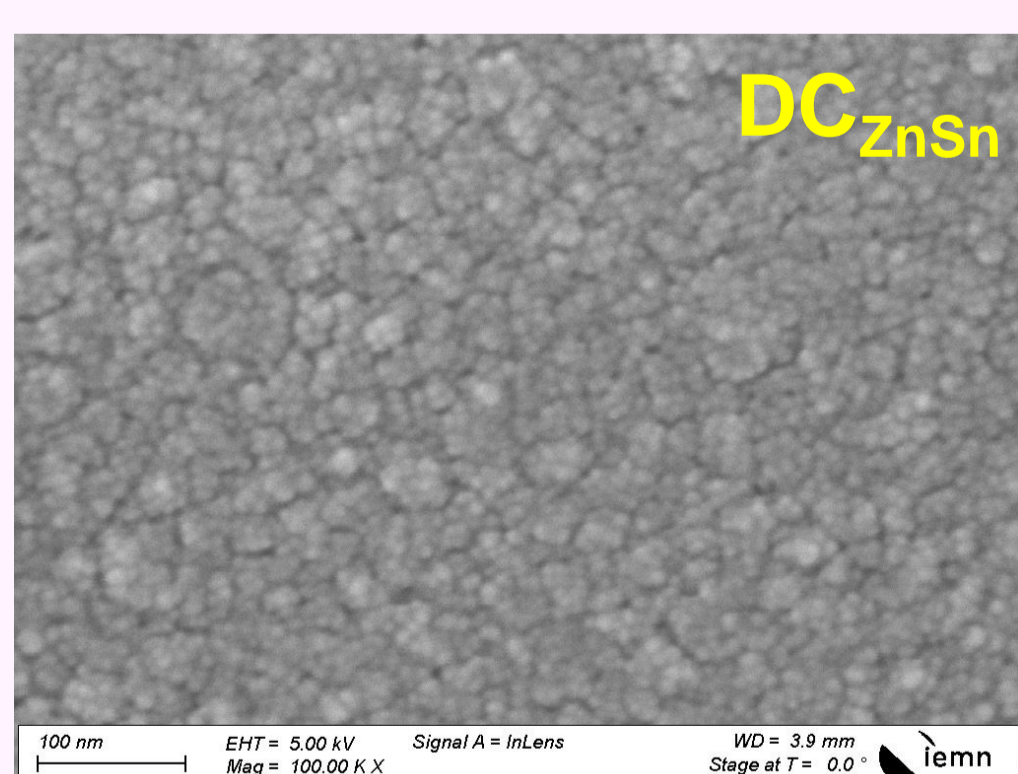
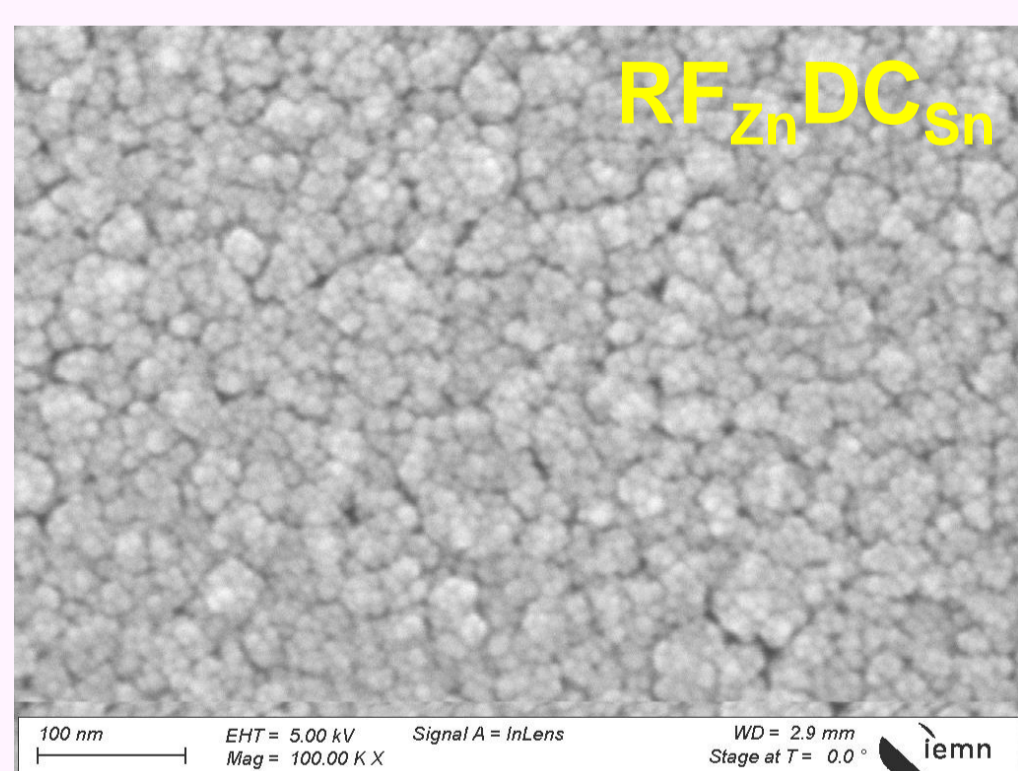
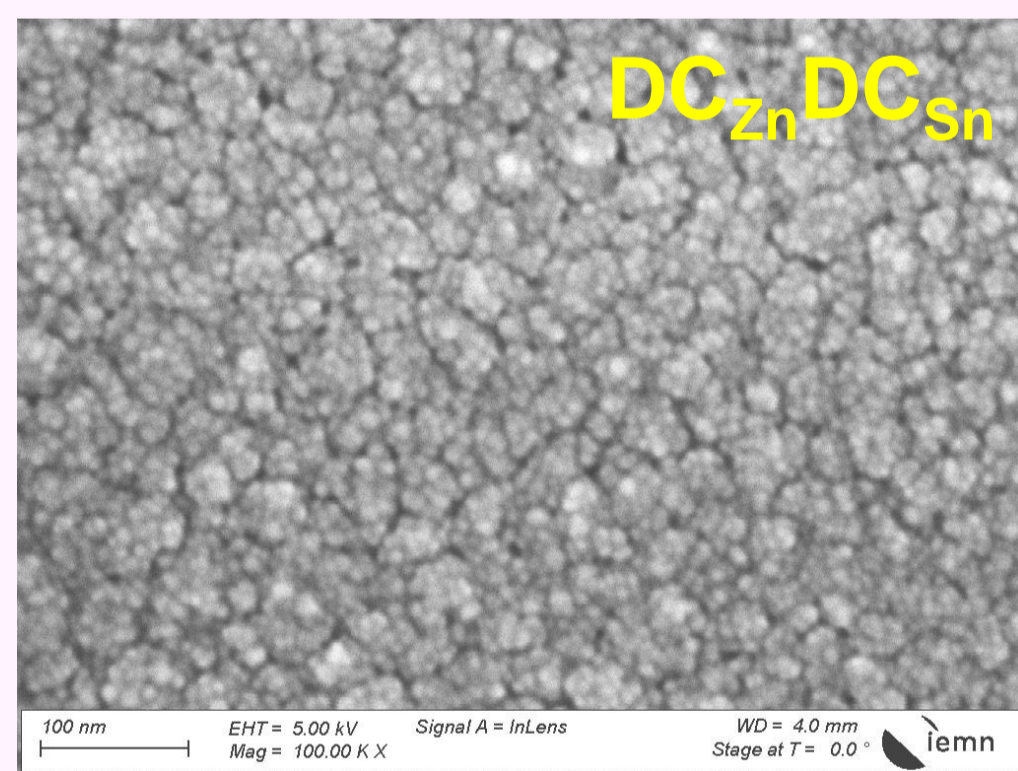
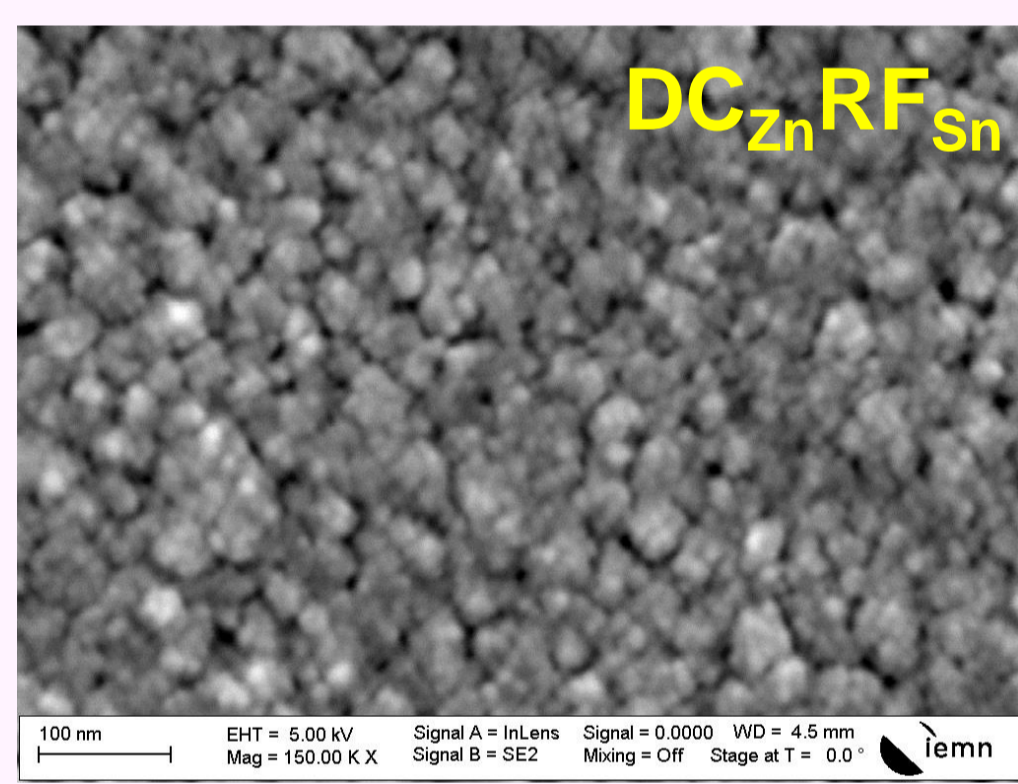


Substrate: Eagle XG, room temperature, 20rpm rotation
 Gas : 10sccm Ar/ 30sccm N₂
 Sputtering Pressure: 0.02 mbar (10⁻⁷ mbar of base pressure)

Results

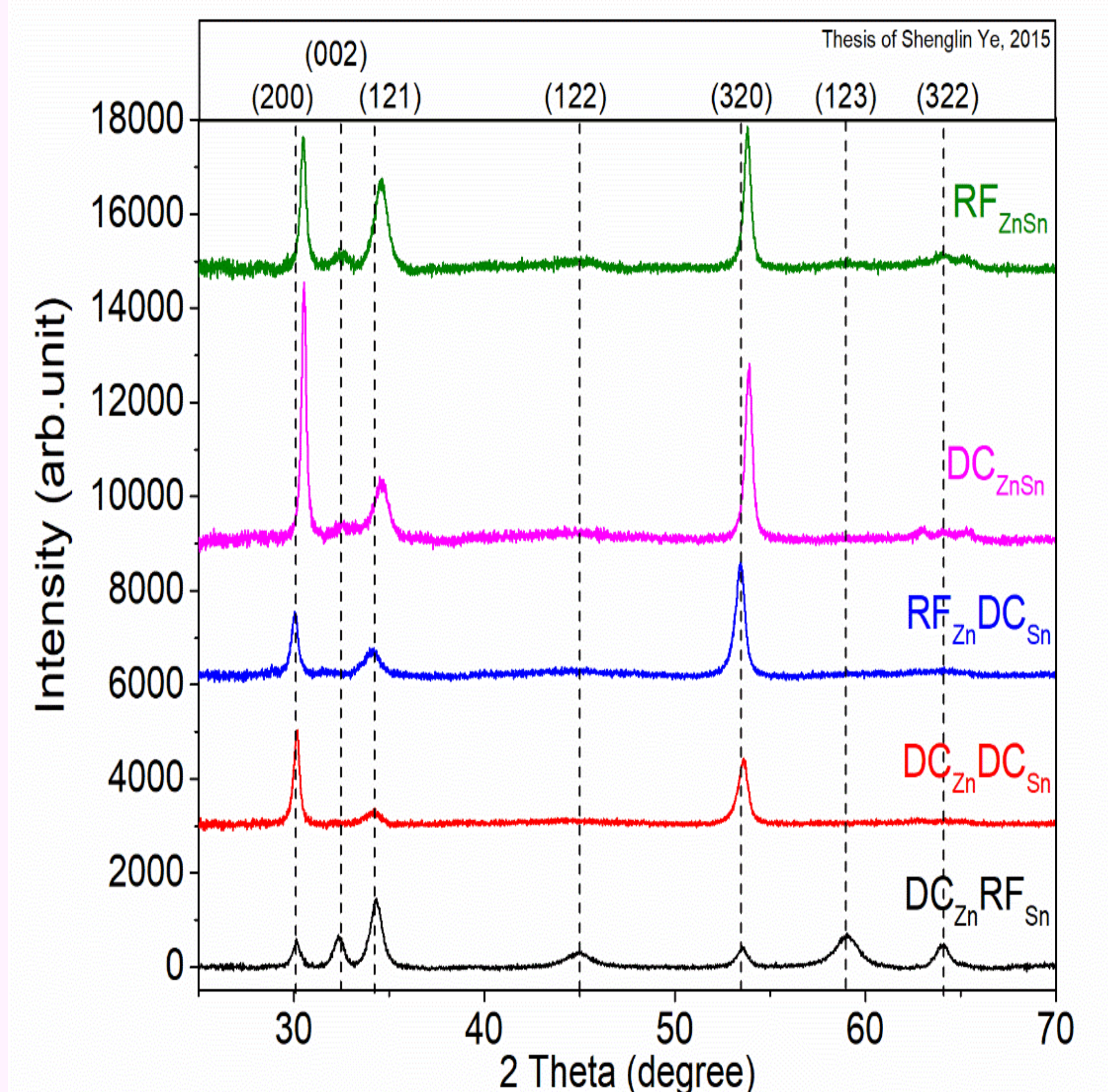
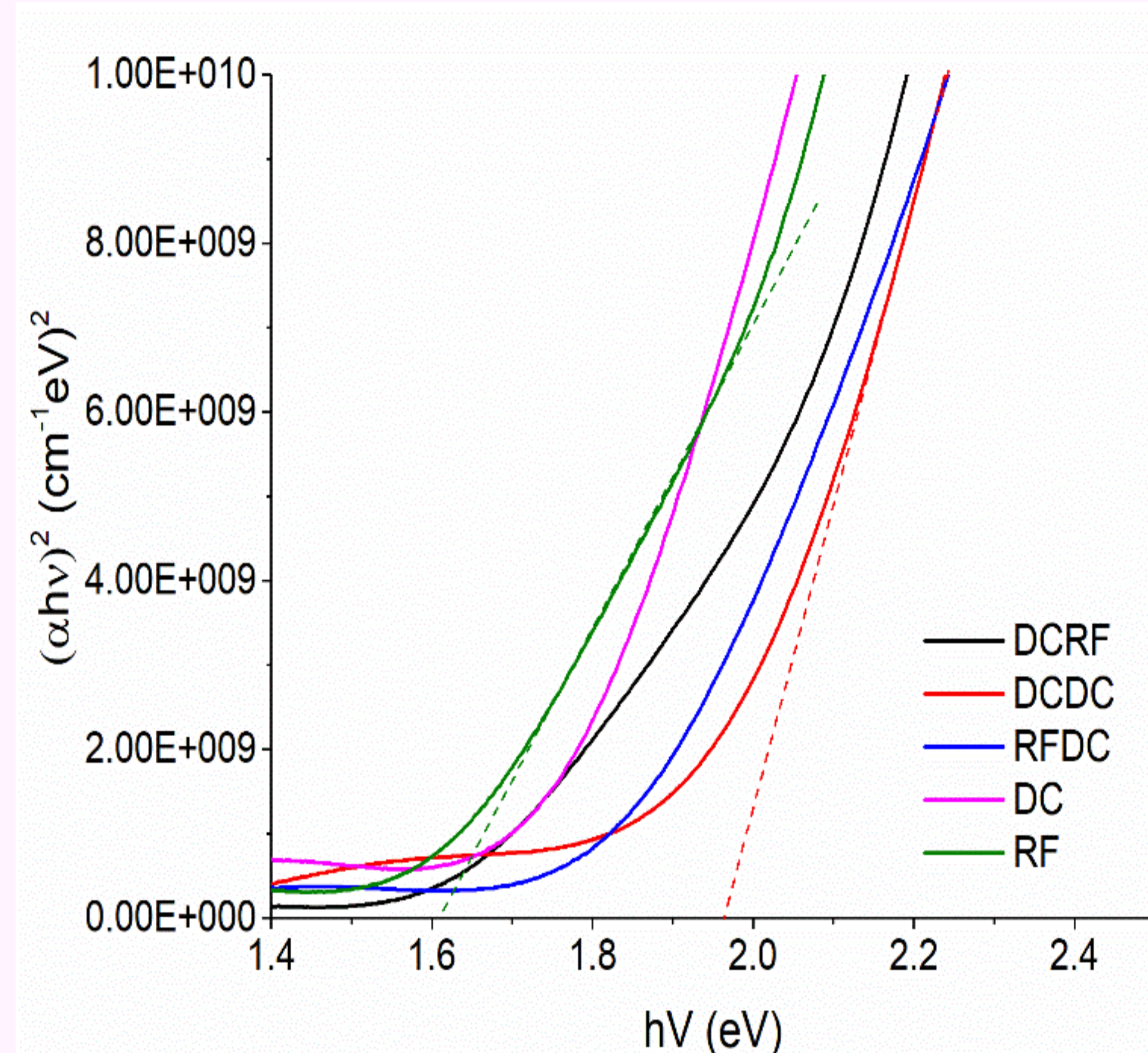
Deposition using different sputtering modes

	2 targets		1 target
	Zn	Sn	Zn _{0.42} Sn _{0.58}
DC _{Zn} RF _{Sn}	DC	RF	
DC _{Zn} DC _{Sn}	DC	DC	
RF _{Zn} DC _{Sn}	RF	DC	
DC _{Zn} Sn			DC
RF _{Zn} Sn			RF



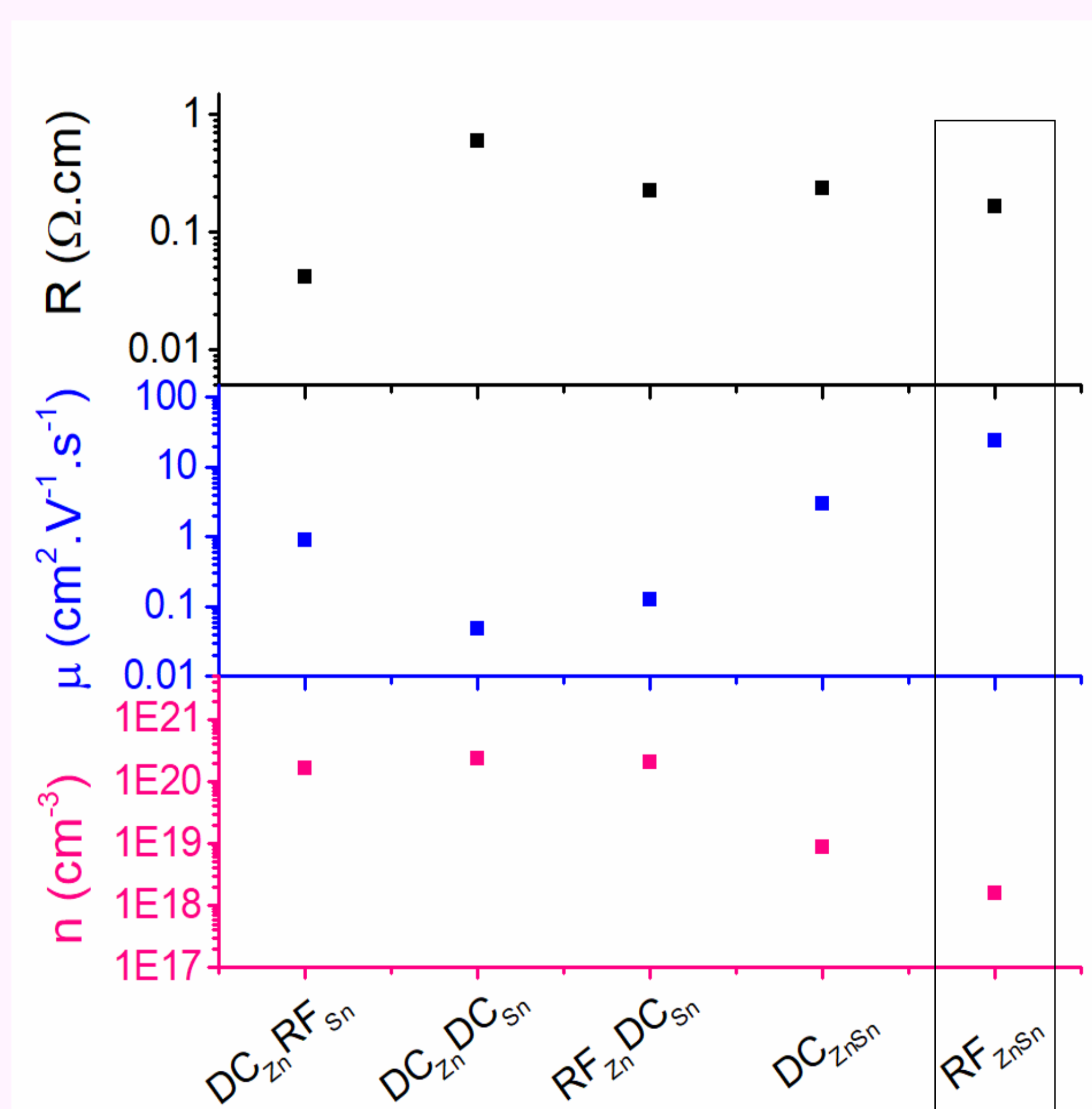
Zn/(Zn+Sn) ~ 46% for all samples (by EDS)

Optical bandgaps were evaluated using UV-VIS Spectrometer and Tauc's relation



DC_{Zn}RF_{Sn} matches all the characteristic peaks of ZnSnN₂

Electrical properties obtained by Hall-Effect measurement system in Van Der Pauw model



Highest carrier mobility, lowest carrier density

Expecting good photoelectric properties

Conclusion

- Sputtering mode (DC, RF) affects the crystalline structure as well as optoelectronic and electrical properties.
- Lowest carrier density (1.60x10¹⁸ cm⁻³) and highest carrier mobility (23.7 cm².V⁻¹.s⁻¹) are obtained for RF_{Zn}Sn sample (gap around 1.6 eV) → photoconductor fabrication is on the way.

