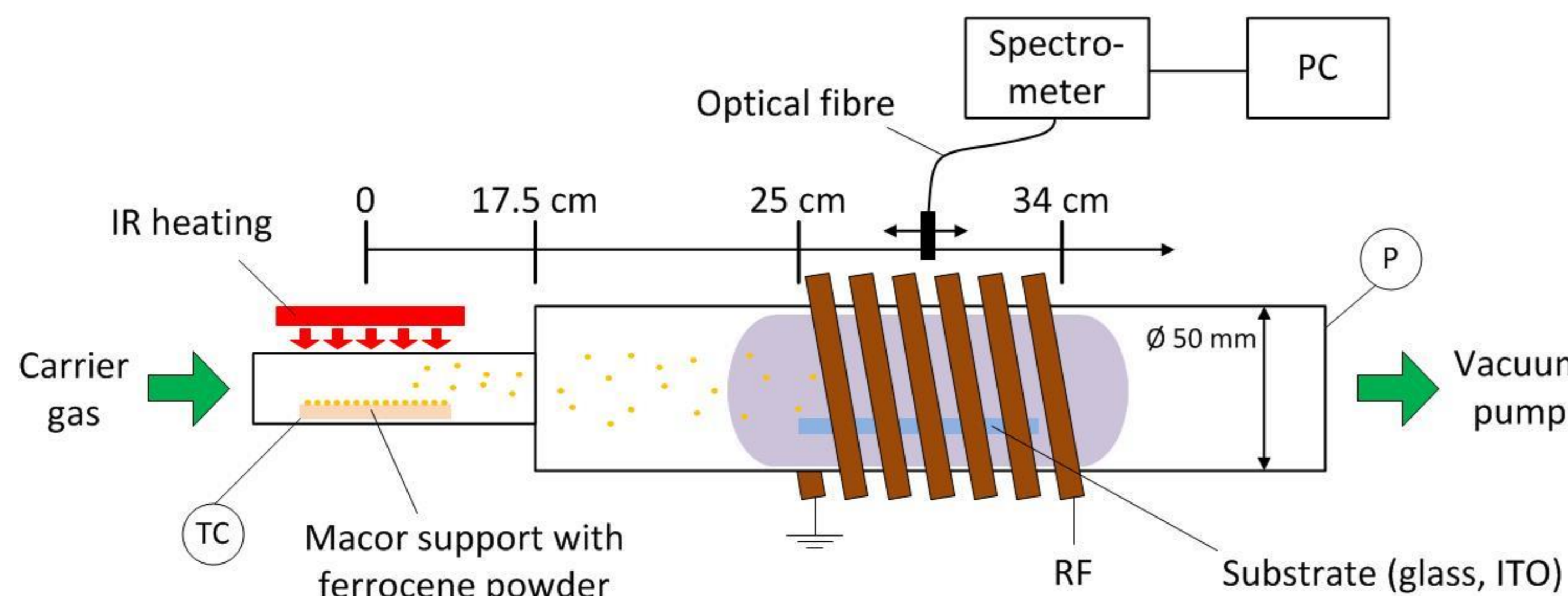


OBJECTIVES

- Feasibility of deposition of nanostructured hematite via PECVD
- Demonstrate the advantages of PECVD versus other deposition techniques, as atmospheric CVD or wet chemistry
- Reduce deposition time by reducing or eliminating post-treatment (air annealing, plasma treatment, ...)

ICP PLASMA DEVICE AND PROCESS PARAMETER SET



- Sublimation of ferrocene powder in the source
- Carrier gas: Ar or Ar-O₂ mixture, 200 sccm of flow, p = 1.6 mbar
- Glass substrates longitudinally inside the plasma
- Independent variation of plasma power (50-200 W), carrier gas composition (pure Ar – Ar-20%O₂) and position (0-7 cm)
- Characterisation of the deposited layers by: SEM, EDX spectroscopy and Raman spectroscopy

RESULTS AND DISCUSSION

- Monitoring the dissociation using optical emission spectroscopy:
 - Choose the position of the substrate
 - Optimise the process parameters (e.g. maximisation of ferrocene dissociation)
- High deposition rate, up to 500 nm/min reached using 70 W plasma power (favouring Fe-C bond cracking)
- Chemical composition (fig. 2 and 3) shows a carbon contamination of about 50%

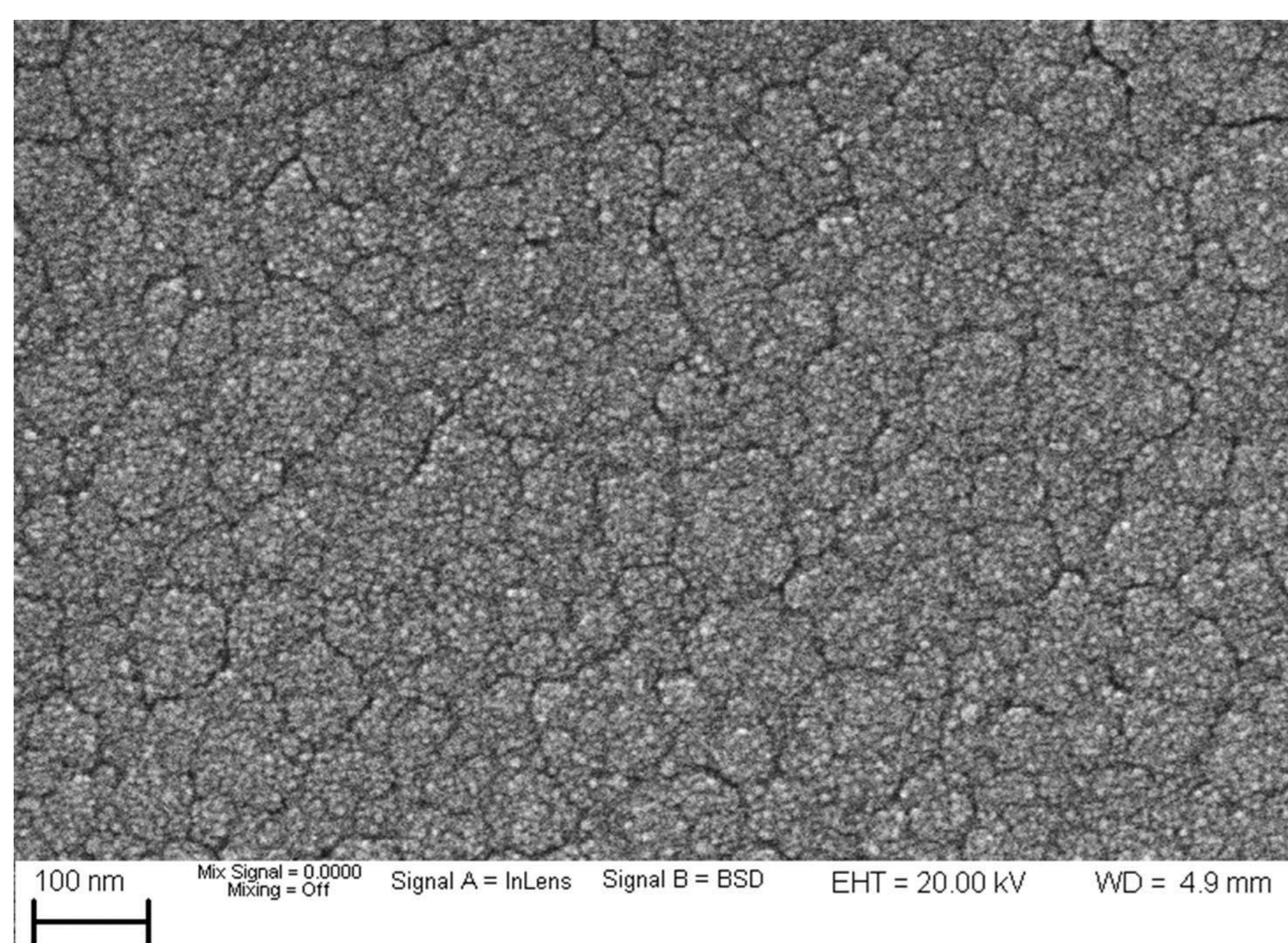


Fig. 1: SEM image of the top of a sample, showing the cauliflower structure of the deposited layer by agglomeration of particles.

Process parameters: 150 W, 200 sccm Ar-20%O₂, 1.6 mbar, ferrocene source T > 100°C, position 26 cm

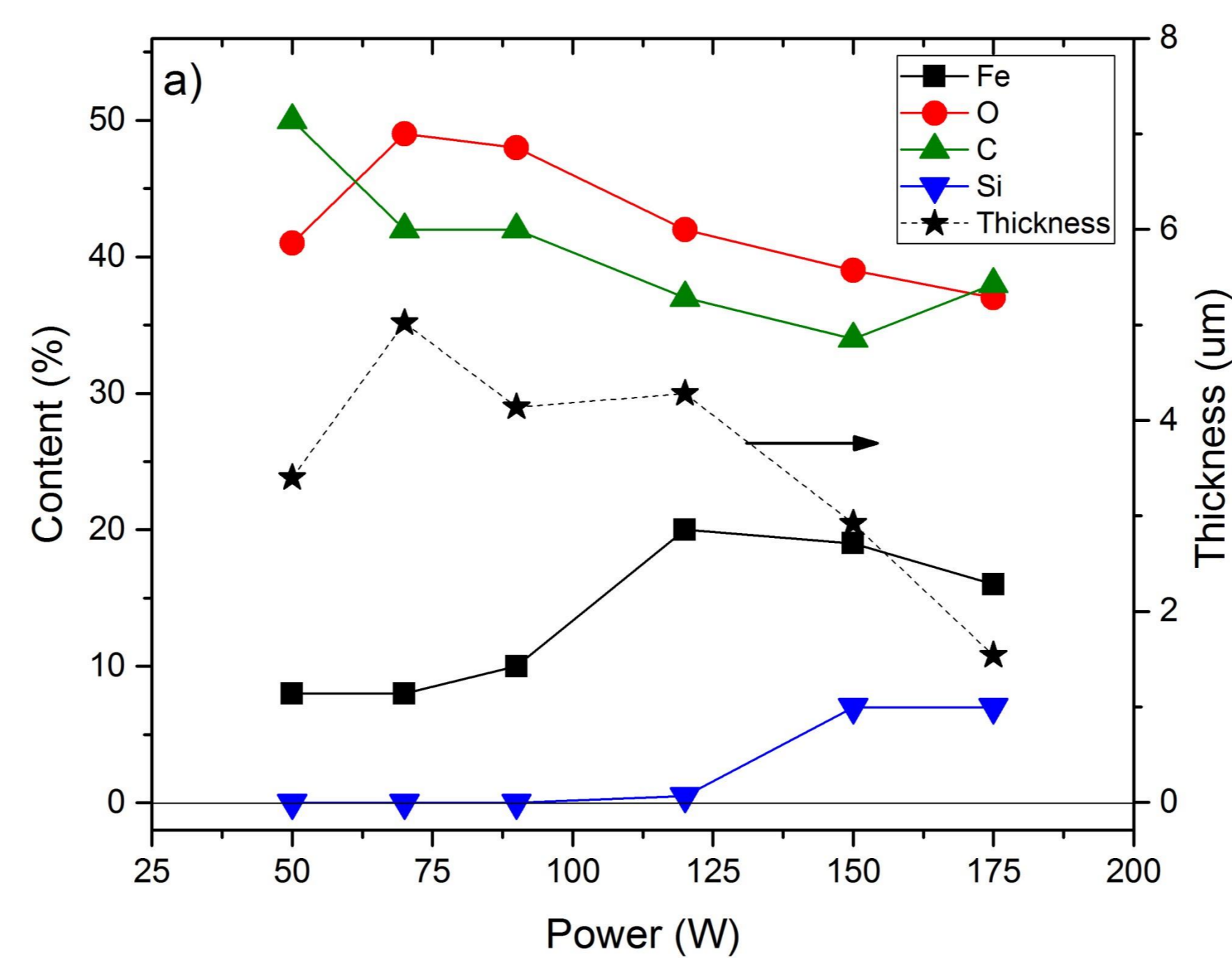


Fig. 2: Chemical composition and thickness measured at 26 cm and after 10 min deposition time

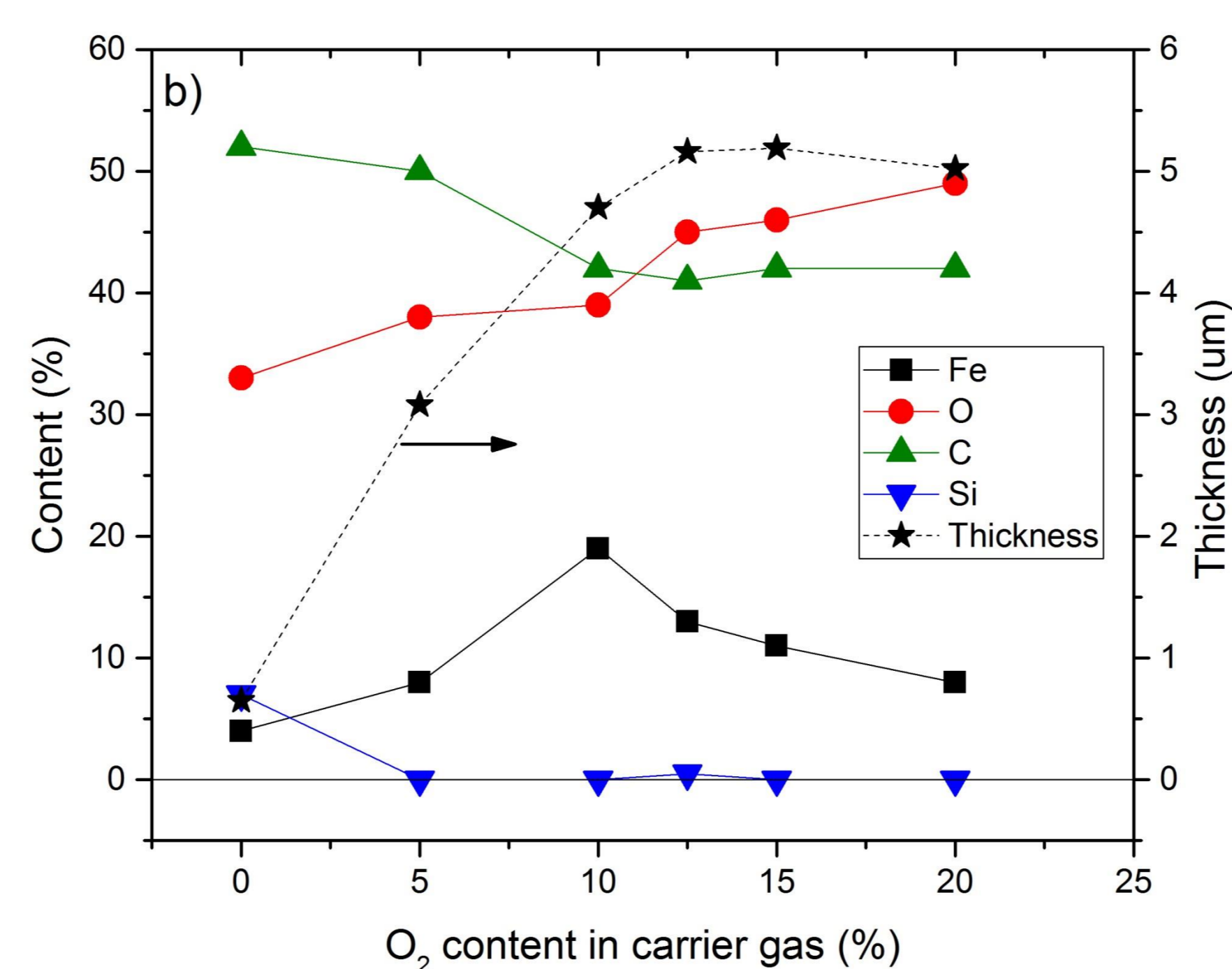


Fig. 3: Chemical composition and thickness measured at 26 cm and after 10 min deposition time

- Fe content is maximal at 120 W and 10% oxygen content in carrier gas

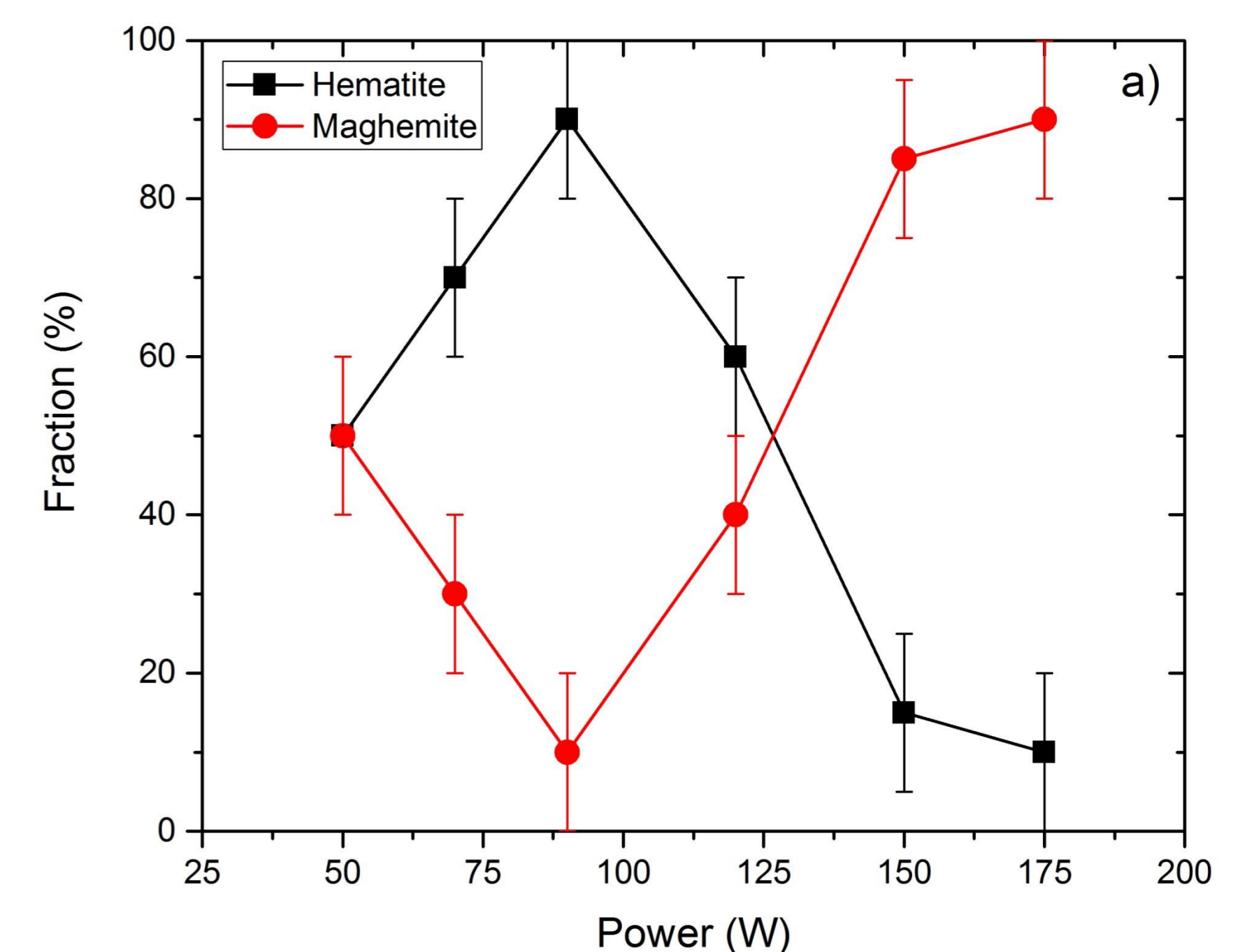


Fig. 4: Hematite phase type maximal at plasma power of 90 W and decreases with power increase

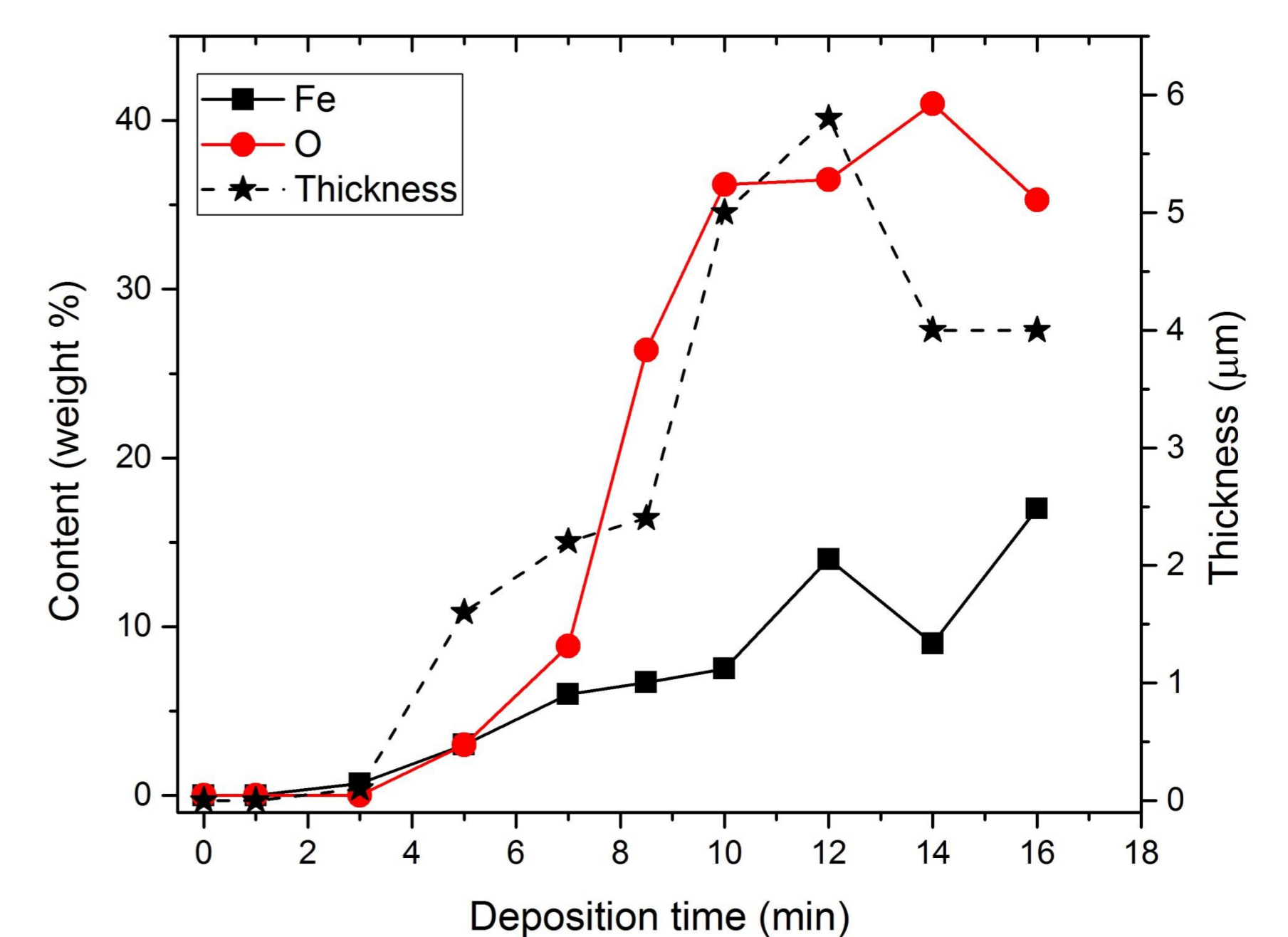


Fig. 5: With longer deposition time, O-weight content as measured by EDX increases faster than Fe-content

- Plasma power > 150 W results in high iron content but poor hematite fraction

CONCLUSIONS

- Direct deposition of hematite via PECVD is possible
- High deposition rate (up to 500 nm/min)
- Independent variation of process parameters:
 - Hematite fraction highly influenced by plasma power
 - Optimum of iron content at 10% O₂ in carrier gas

OUTLOOK

- Reduce carbon contamination
- Optimisation of the process parameters for PEC performances
- Increase sample size
- Understand the growth mechanism (simulations, calculations, OES, ...)
- Determine the layer properties: conductivity, absorption coefficient, ...
- Vertical profiling of layer properties