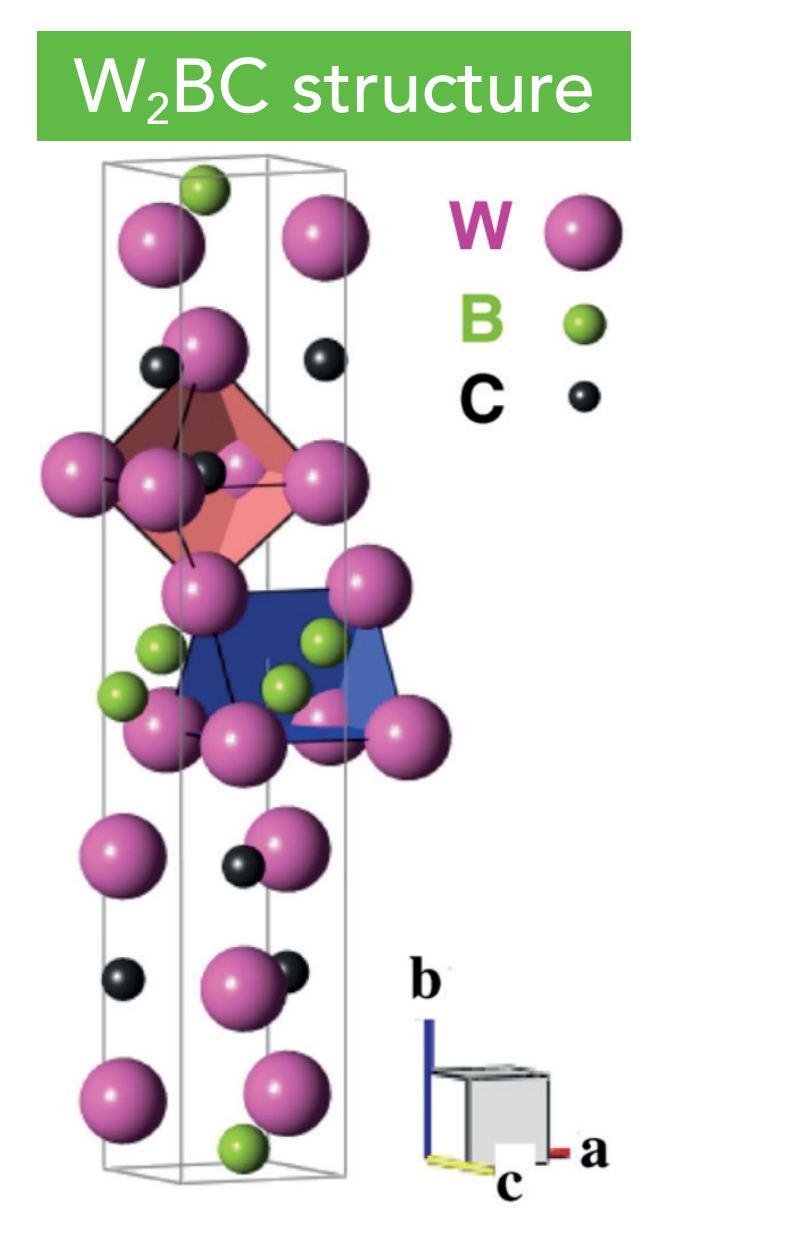


## MOTIVATION

- Standard hard protective coatings for tools are generally brittle
- Coatings should simultaneously exhibit high hardness and enhanced ductility to prevent formation and spreading of cracks
- According to *ab-initio* calculations  $W_2BC$  with inherently nanolaminated unit cell should exhibit such a combination of properties <sup>a)</sup>

<sup>a)</sup>Bolvardi, H., Emmerlich, J., to Baben, M. et al., (2013). Systematic study on the electronic structure and mechanical properties of  $X_2BC$  (X = Mo, Ti, V, Zr, Nb, Hf, Ta and W). *Journal of Physics. Condensed Matter: An Institute of Physics Journal*, 25



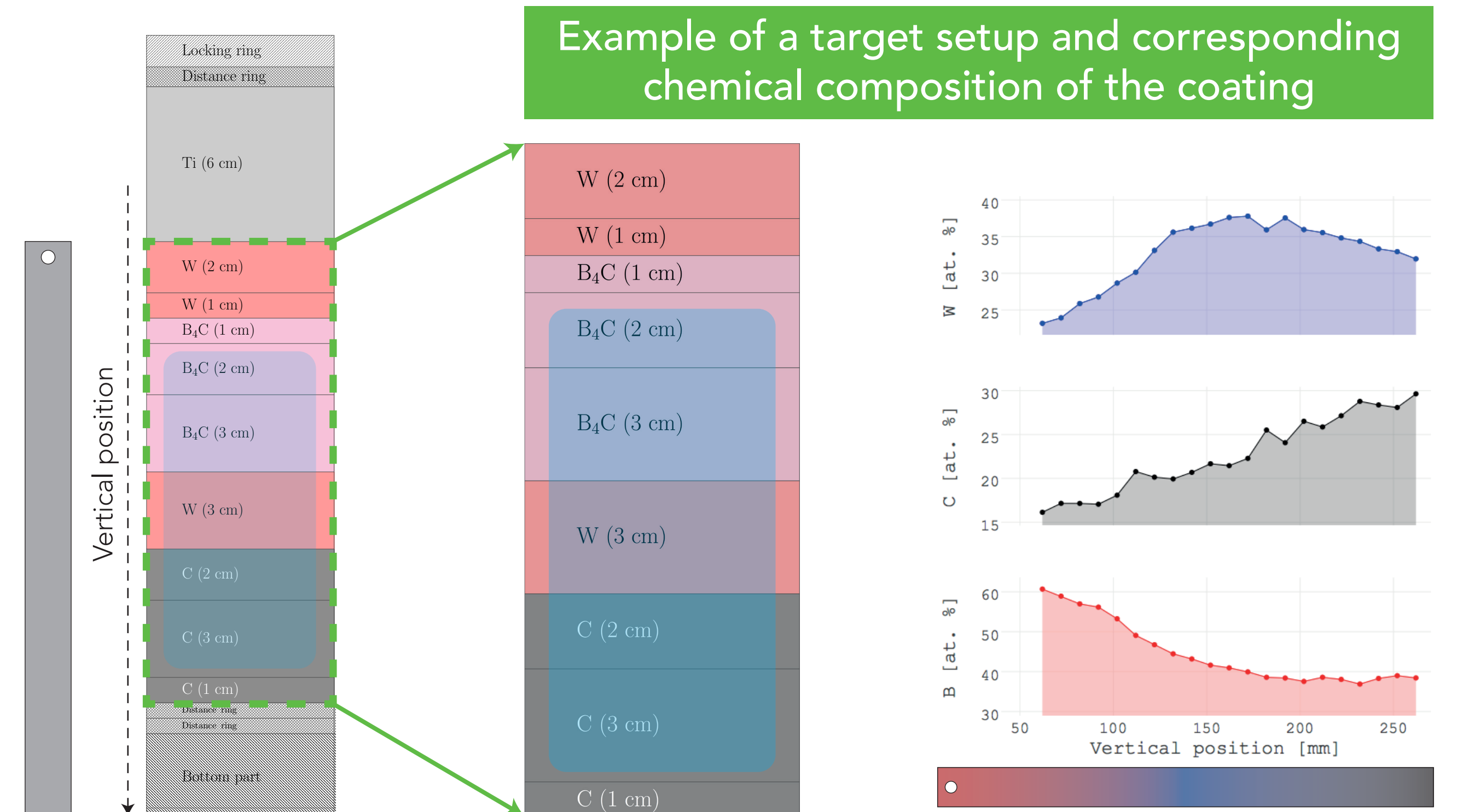
## Deposition parameters

Method	DC-MS
Pressure	0.5 Pa
Working gas	argon
Bias	-100 V
Temperature	450 °C
Substrate	flat steel bar

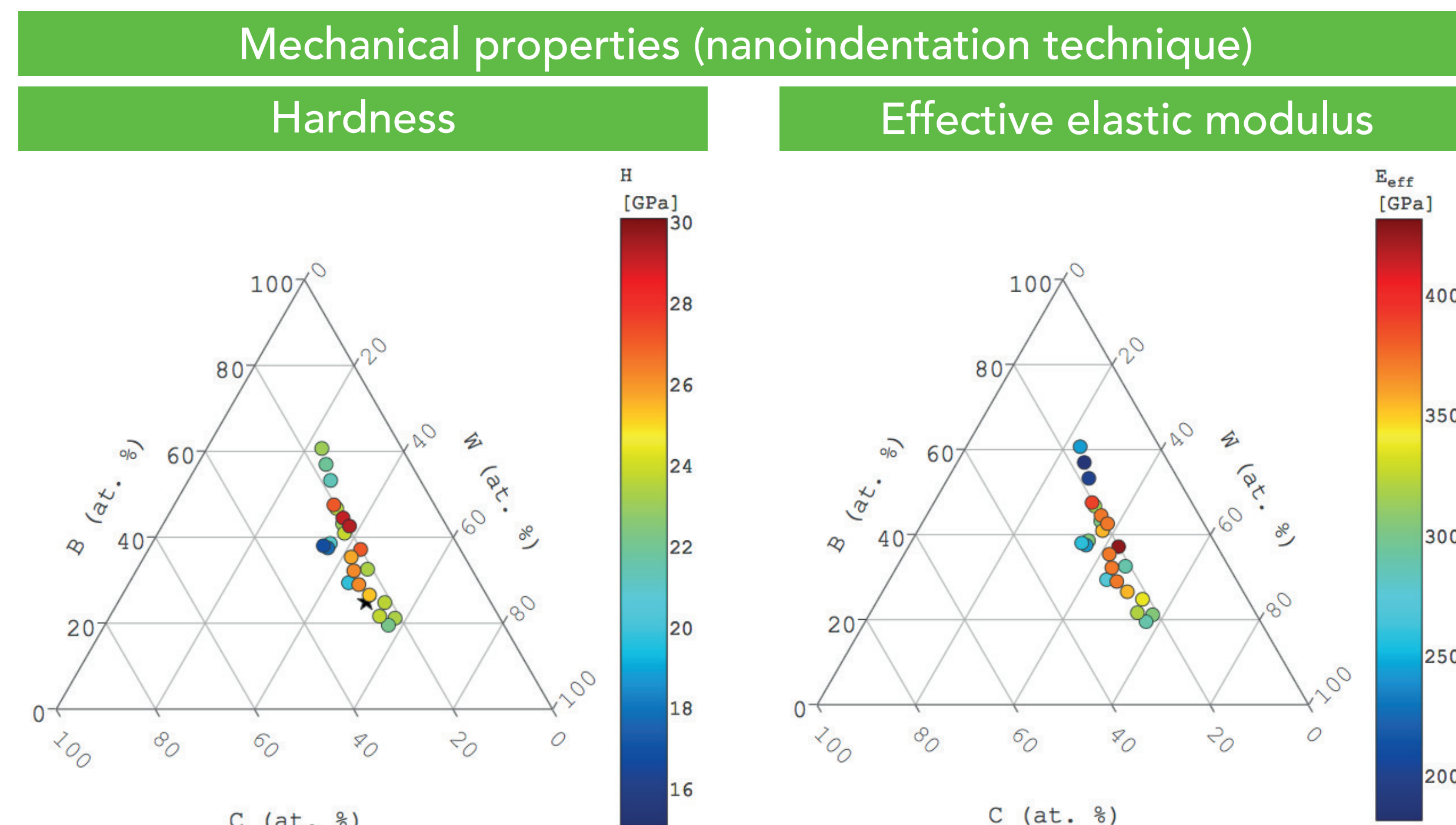
- Flat steel bar substrate placed along the vertical axis of the target for seamless analyses of the deposited coating

## EXPERIMENTAL

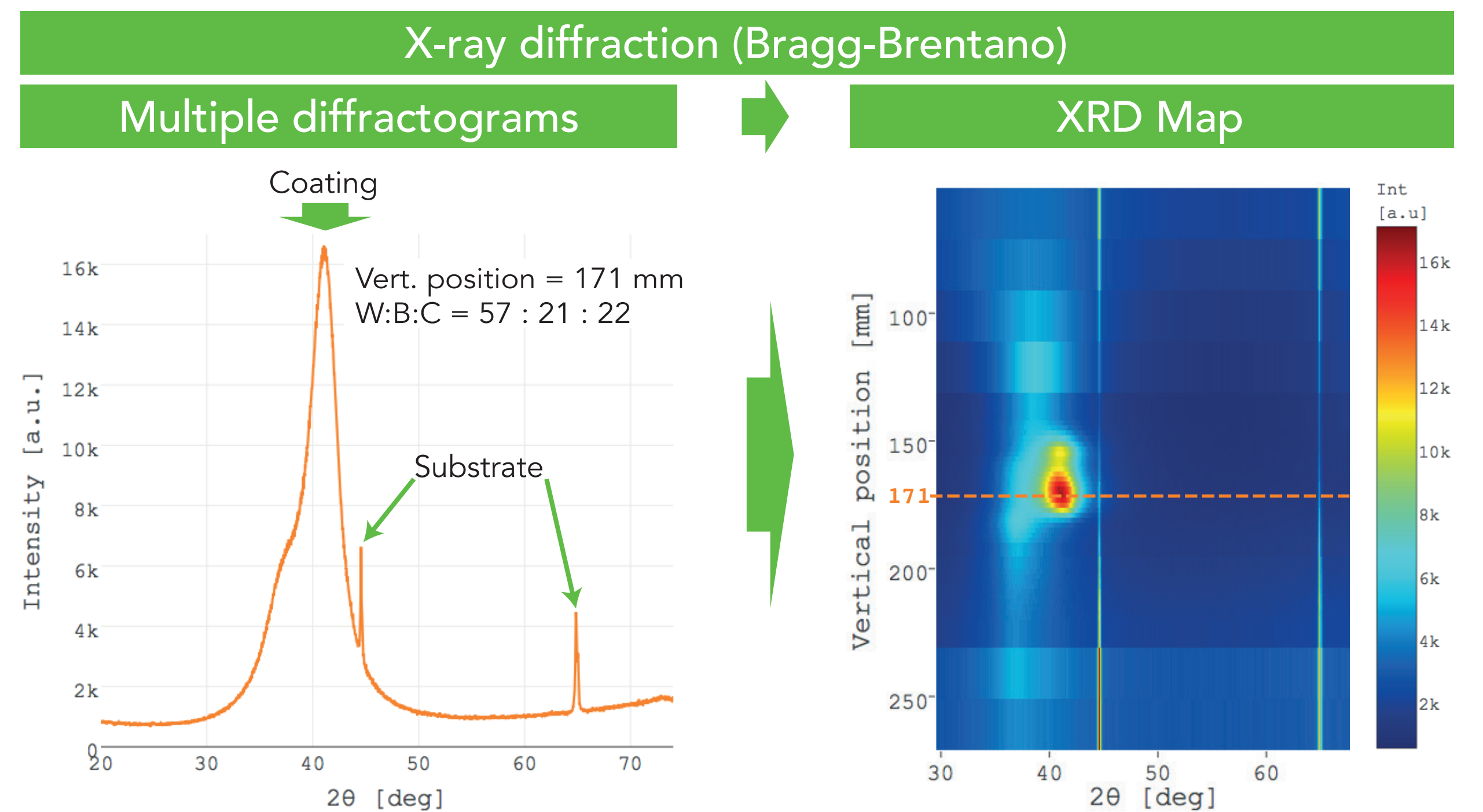
- Experimental magnetron sputtering system with industrial cylindrical cathode
- Segmented target (tungsten, carbon, boron carbide) was used to deposit highly inhomogeneous coatings
- Chemical composition measurement was done using EDS after correlation with RBS
- Coatings properties were studied along the vertical axis of flat steel bar substrate to observe the influence of chemical composition



## RESULTS AND DISCUSSION



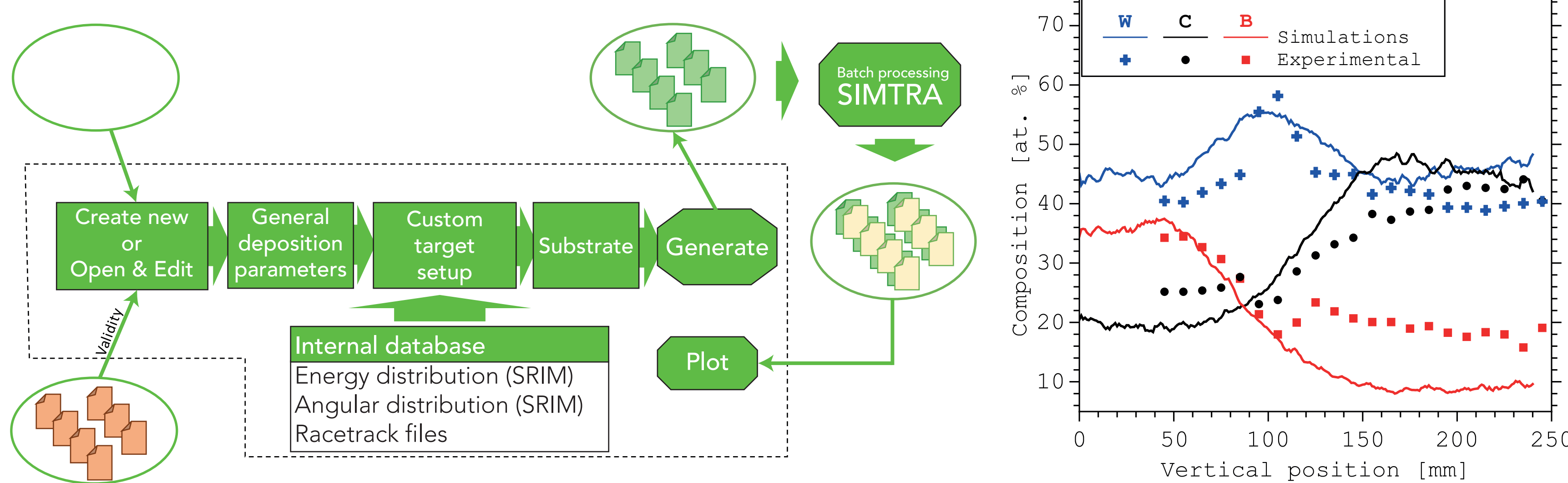
Ternary diagrams describe how the chemical composition influences the mechanical properties of the coating. Both hardness and elastic modulus were determined by nanoindentation techniques using Hysitron TI 950 with diamond Berkovich tip. Strong correlation between mechanical properties and chemical composition is observed.



X-ray diffraction was measured along the vertical axis of coated steel bar substrate. Multiple diffractograms were merged into an XRD map describing the evolution of the coating structure. The appearance of a sharper diffraction peak centered at 41° is observed for stoichiometry W:B:C = 57:21:22.

## SIMULATIONS

- Software for simulating chemical composition of various segmented targets based on SIMTRA<sup>b)</sup> and SRIM is under development



<sup>b)</sup>The metal flux from a rotating cylindrical magnetron: a Monte Carlo simulation K. Van Aeken, S. Mahieu, D. Depla, *Journal of Physics D.: Applied Physics* 41 (2008)

## Conclusions

- Precise control of chemical composition with segmented target is feasible
- Strong correlation between mechanical properties and chemical composition is observed
- XRD shows significant evolution of coating structure within narrow interval of chemical composition
- Simulations have proven to be a good approach for estimating the chemical composition of coatings

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