

Advanced fiber characteristics by carbon nanotubes - What we did not expect

Andres Petr[§], Steffen Oswald[§], Robert Heider[§], Johanne Neuhofer*, Silke Hampel[§]

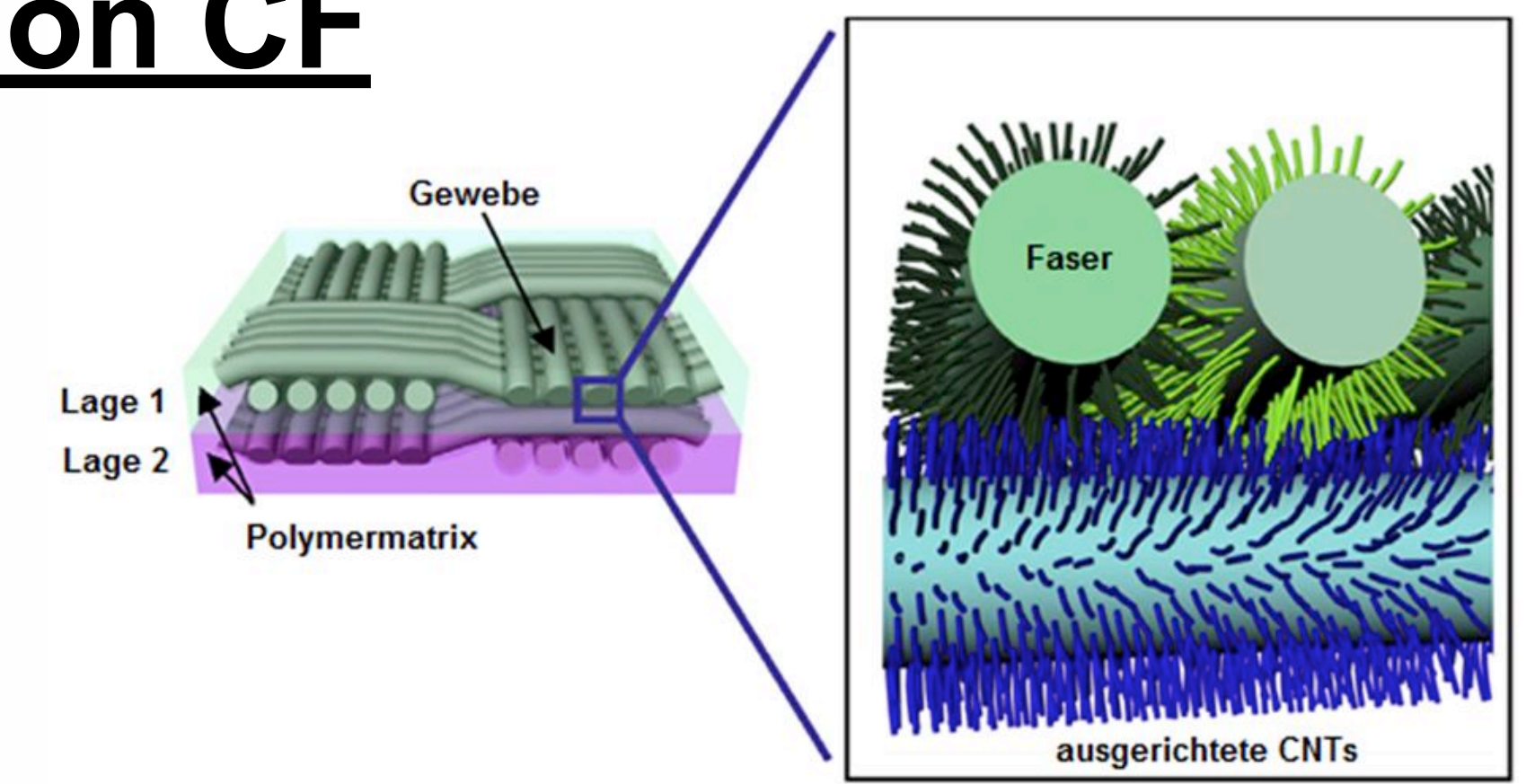
* Faserinstitut Bremen e.V.; § Leibniz Institute for Solid State and Materials Research Dresden

CFRP and CNT

- ❖ Increasing application of hybrid structures in terms of lightweight design
- ❖ Carbon-fiber-reinforced plastic (CFRP) are important
- ❖ Improving of carbon fibres (CF) with carbon nanotubes (CNT)
- ❖ Transferring excellent properties of CNT **from nano to bulk** scale
- ❖ CNT are very mechanical stable, electrical conductive and corrosive resistant

Radial aligned CNT on CF

- ❖ Improvement of delamination resistance
- ❖ Enhancement of interlaminar fracture toughness
- ❖ Heat and electrical conductivity

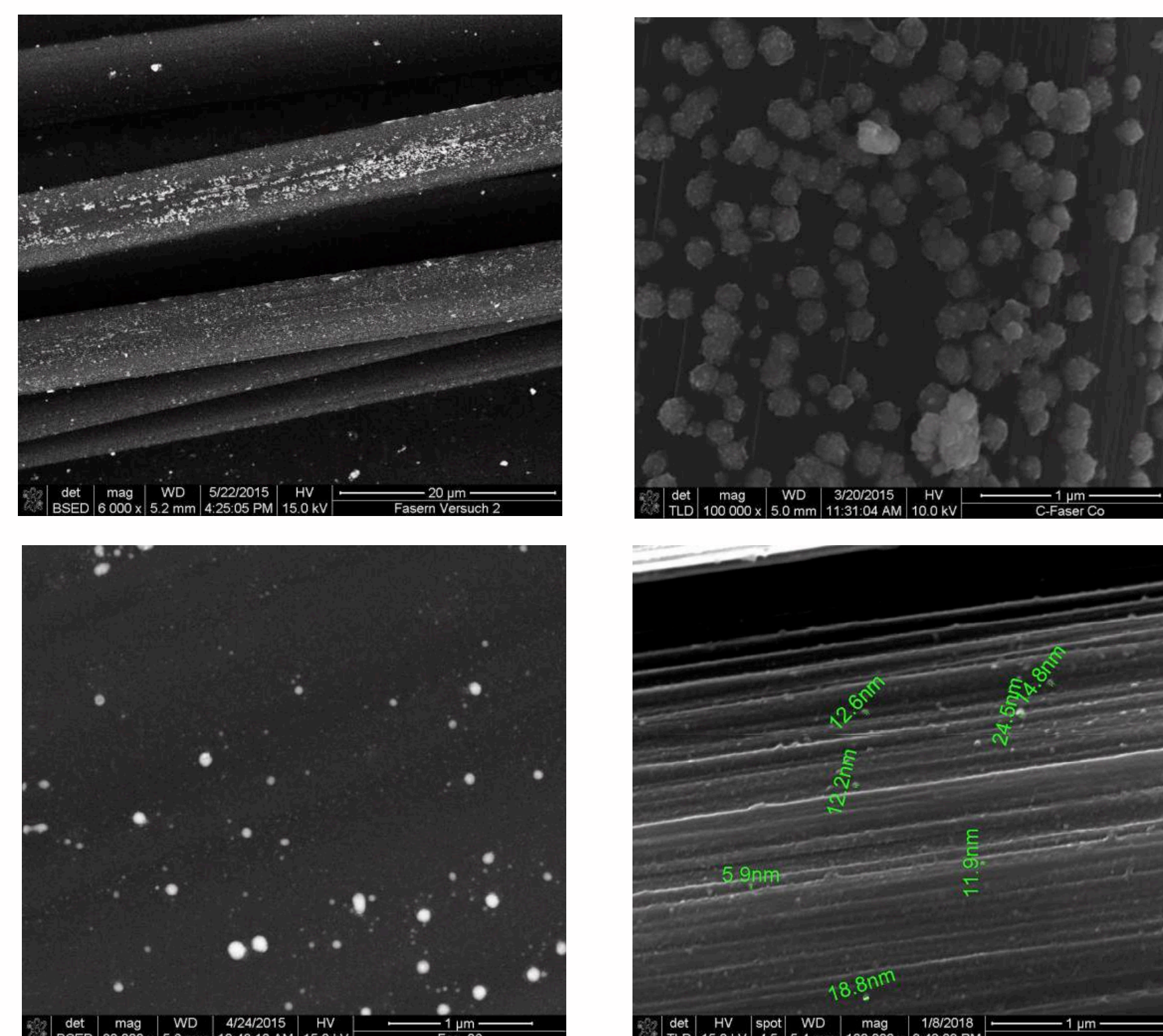


[Wick2010]

Improvement of CF with Co Nanoparticles

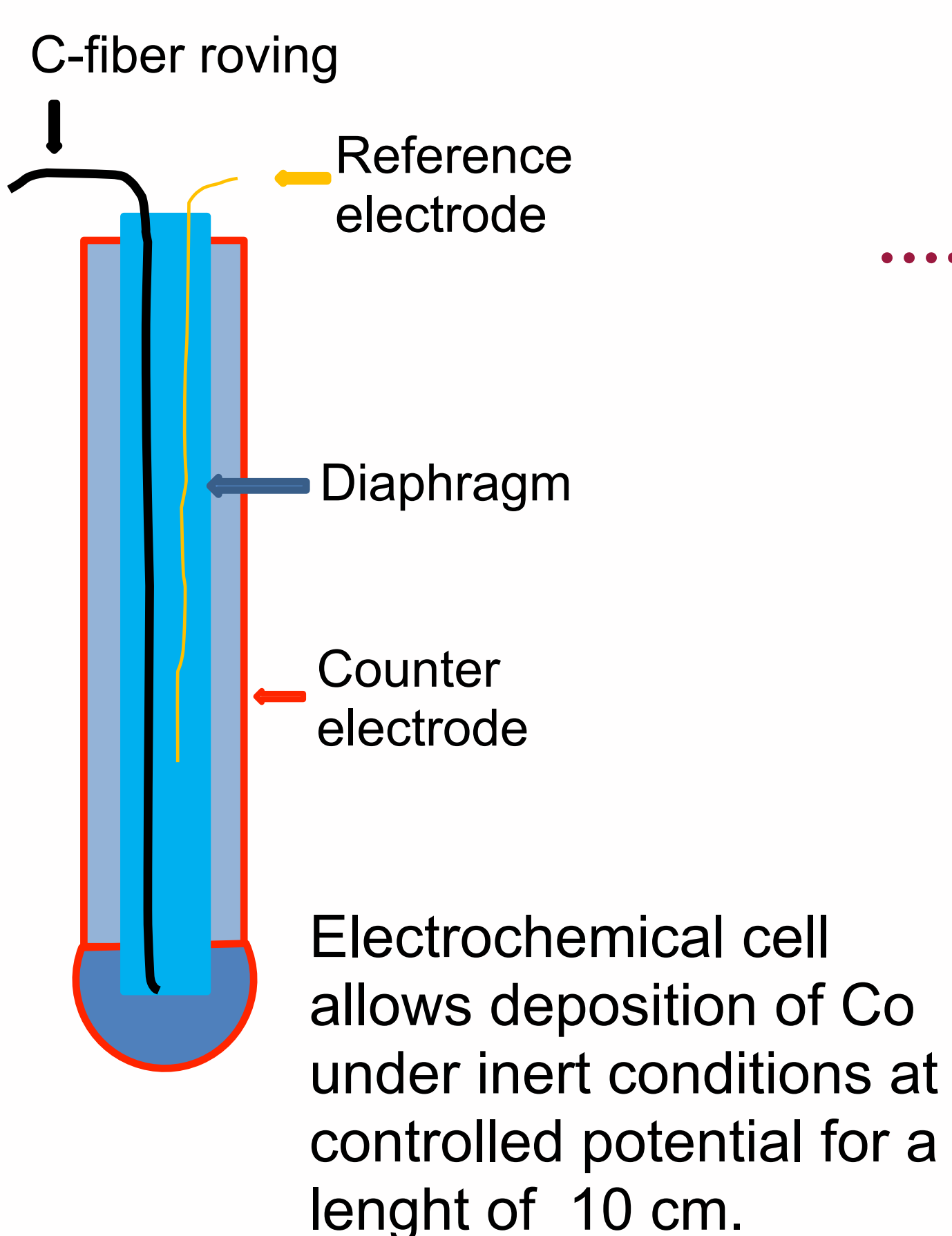
- ❖ Catalyst nanoparticles (Co) on CF are needed for CNT growth
- ❖ Controlled deposition of Co nanoparticles with small diameter
- ❖ High density and regular arrangement is needed
- ❖ **Best option: electrochemical deposition**

Dip coating Potentiostatic deposition
(2 mM CoBr₂ solution)



Regular arrangement of Co nanoparticles with very thin diameter by electrochemical deposition

Scheme of an electrochemical cell for Cobalt deposition



Surface groups on CF were removed!

CF	C1s	N1s	O1s	Na1s	S2p
As obtained	81.36	0.85	17.23	0.11	0.28
Thermal treated (H ₂)	96.49	1.46	1.74	0.07	0.00

Despite the removal of surface groups – the fibres are stronger bound to the matrix!

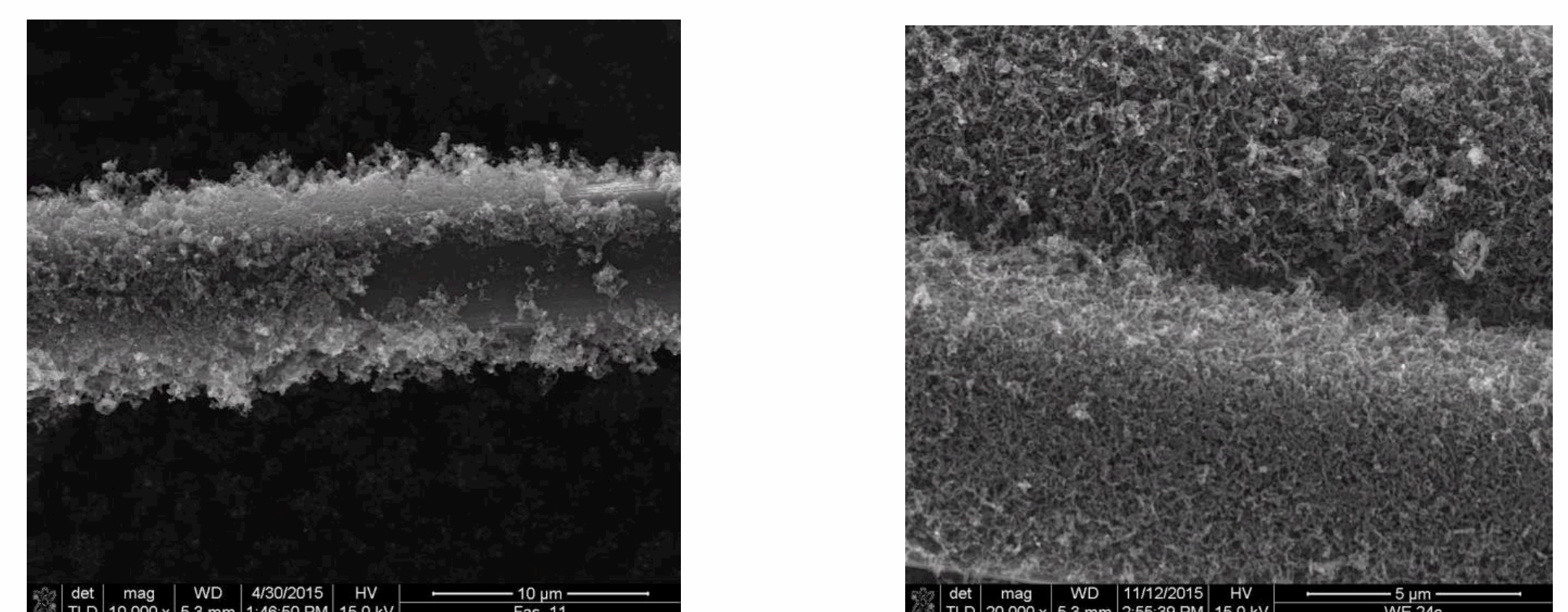
Maximum force (F _{max})	Original-Roving	Roving with CNT
Average (cN)	16,02	21,07
Standard deviation (cN)	2,86	1,03
Coefficient of variation (-)	0,18	0,05

CNT increase the pull out force in epoxy resin by 30%.

Growth of CNT by CVD Process

CNT growth on CF by chemical vapour deposition (carbon source C₂H₂; temperature 750 °C)

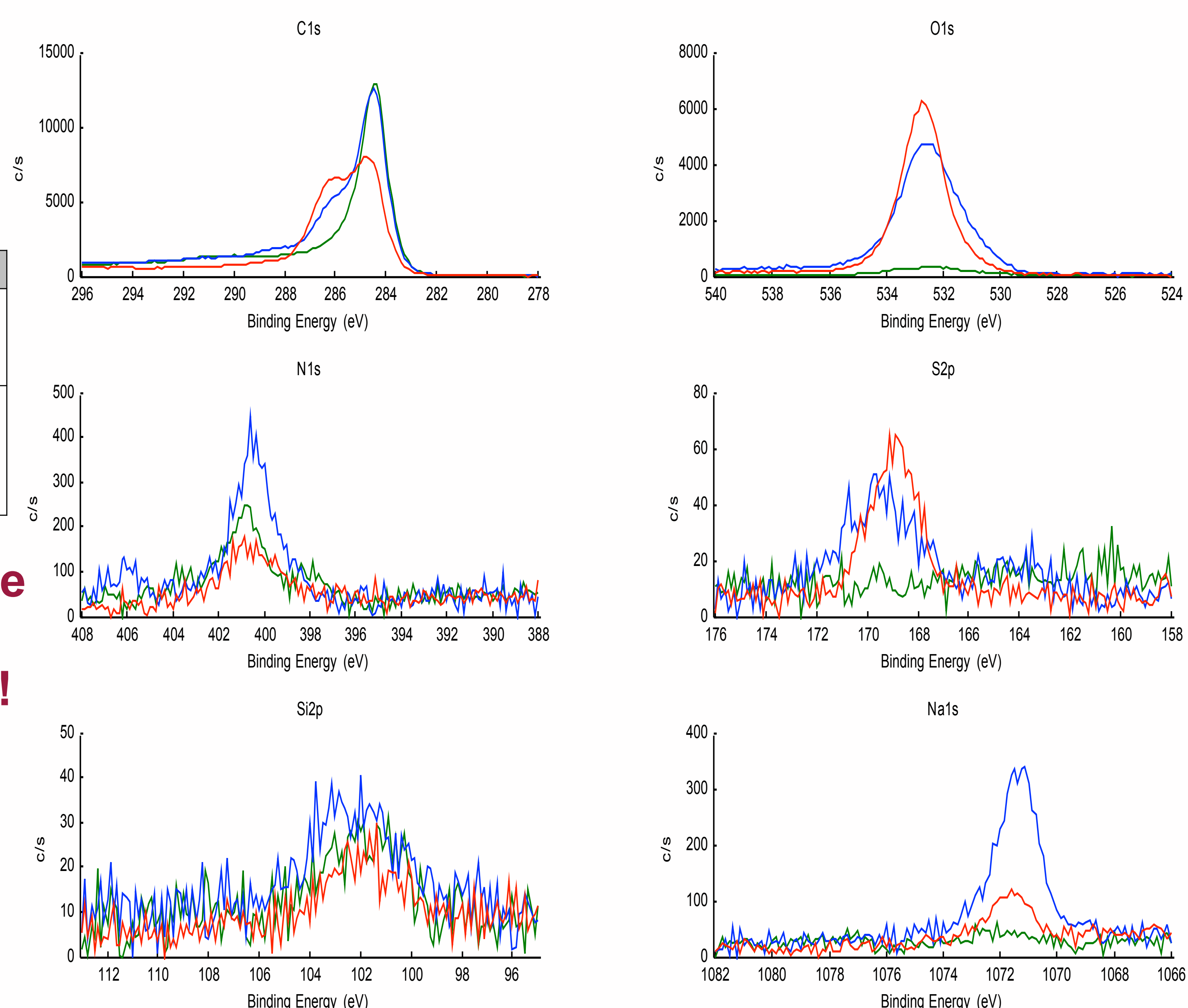
Dip coating Potentiostatic deposition



Regular radial aligned CNT on CF

XPS measurement on different treated CF

- CF as obtained (with sizing)
- CF sizing removed with HNO₃
- CF sizing removed by thermal treatment (H₂)



Acknowledgment

Thank you to Steffi Kaschube for XPS investigations.