EUROPEAN UNION

GOVERNMENT OF ROMANIA

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Structural Funds
2007-2013

Romania – Republic of Serbia
IPA Cross-border Cooperation Programme

Characterization of surface layer-deposited structures

Universitatea Politehnica Timișoara

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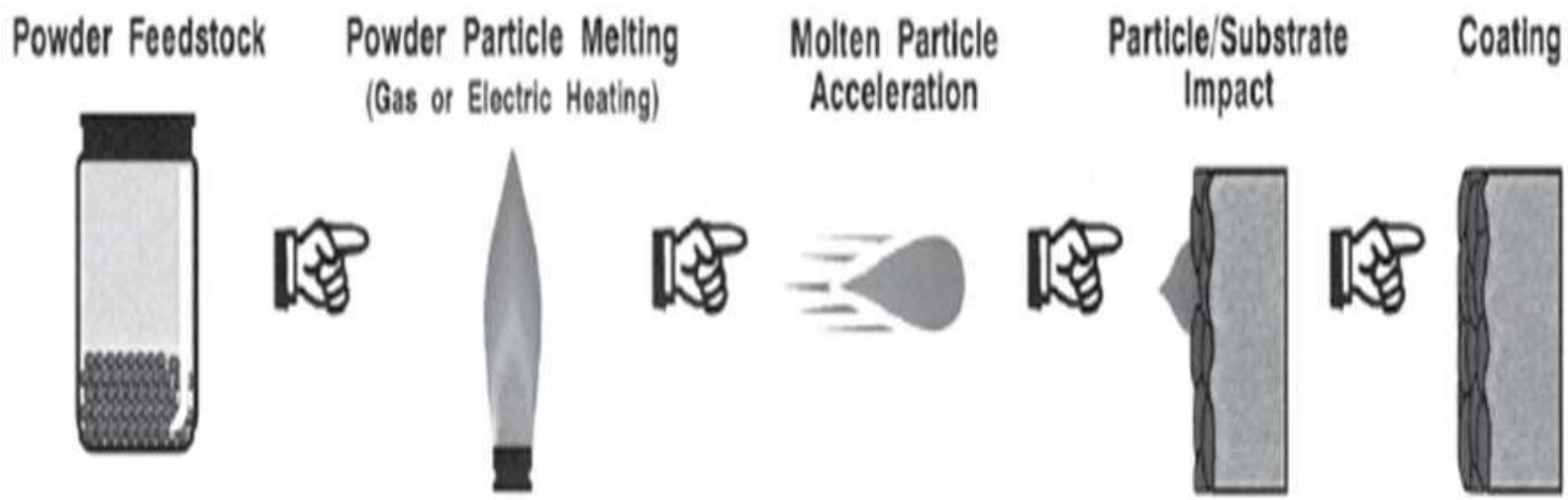
Thermal spray coating - coating produced by a process in which molten or semi-molten particles are applied by impact onto a substrate



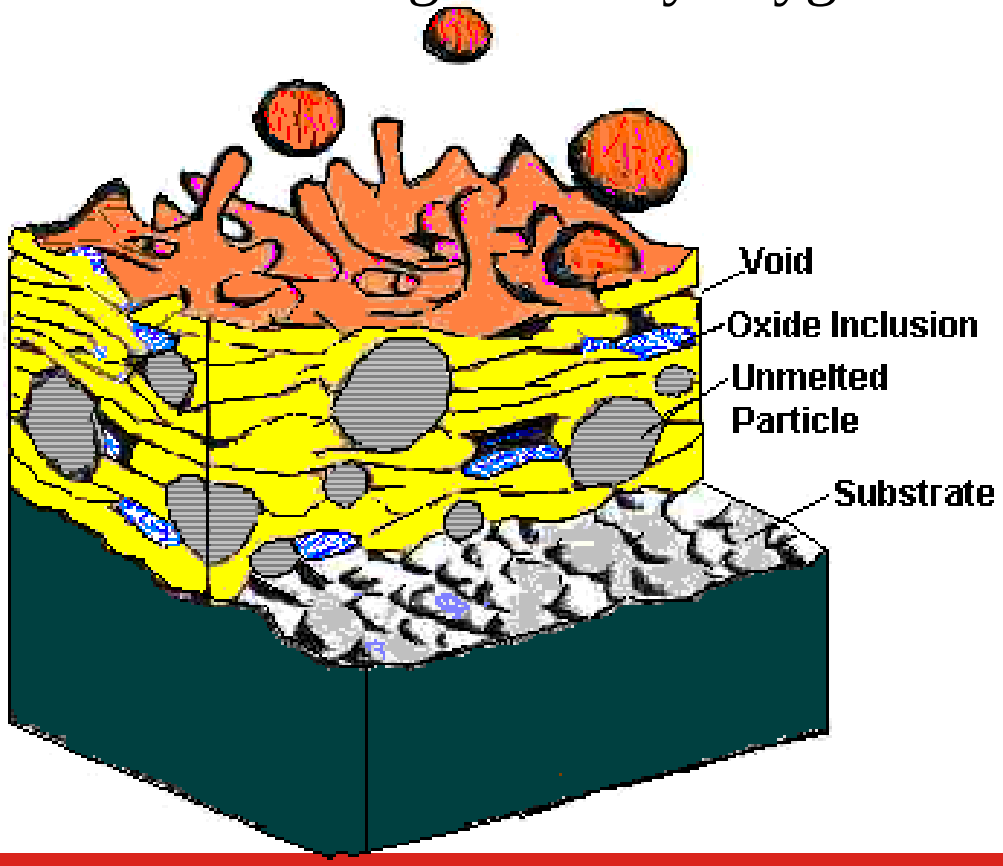
Thermal spray coating process

Thermal spraying methods:

- plasma spraying:- atmospheric plasma spraying (APS)

- vacuum plasma spraying (VPS)

- high velocity oxygen-fuel (HVOF)



Drawbacks:

- internal oxide formation - low passivity

- open pores and crevices between lamellae

- degradation of material during spraying

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Investigation on high-velocity-oxygen-fuel-sprayed specimens of CoNiCrAlY powder with 8 wt.% Al and WC-Co powder with different WC grain sizes

MCrAlY coatings

- Structural modifications in the MCrAlY coatings before and after EB remelting
- structure and thickness of the grown oxide scale

WC Co 83 17/Al8Si20BN coatings

- variation of the coatings morphology
- corrosion and wear resistance behaviour

Experimental results

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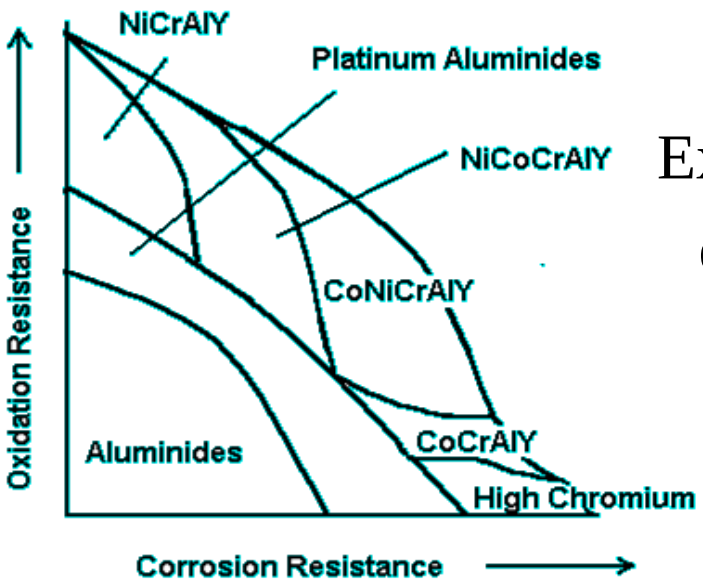
MCrAlY‘s are a family of materials which have a base metal(M) of cobalt, nickel, and or iron, plus chromium, aluminium, yttrium and sometimes other alloying elements.



Excellent performance at elevated temperatures and corrosive type environments

MCrAlY coatings

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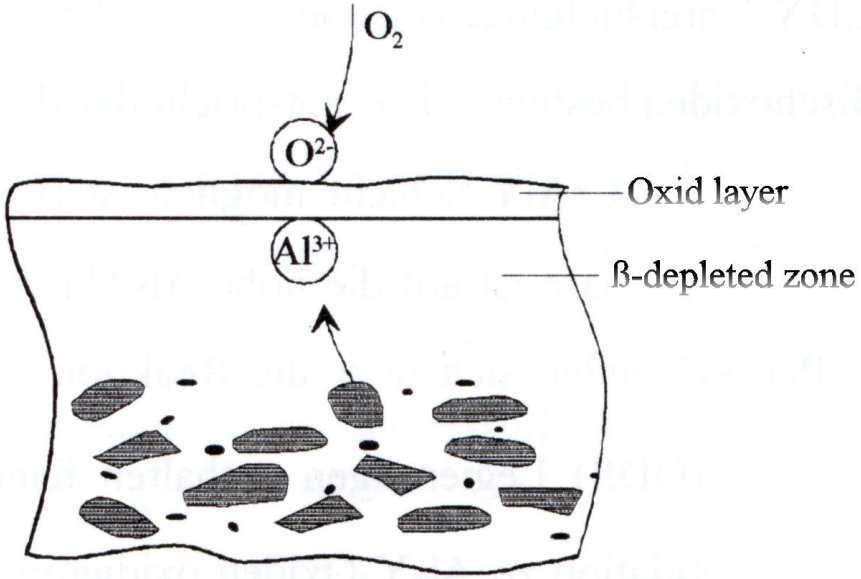

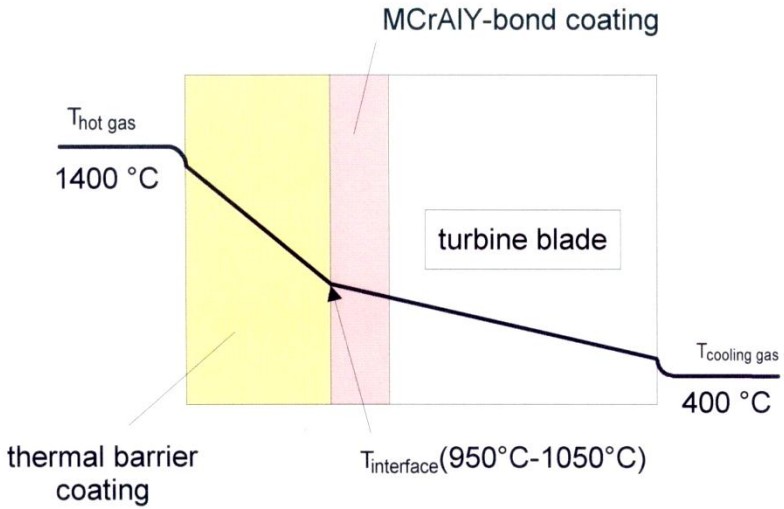

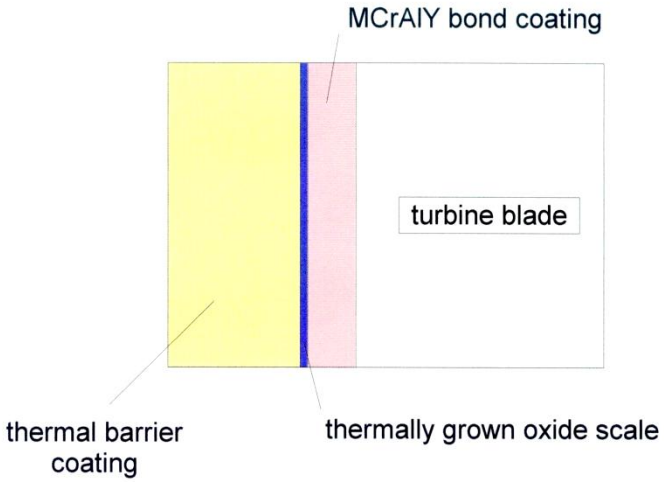

Thermal barrier coating system and temperature gradient during service

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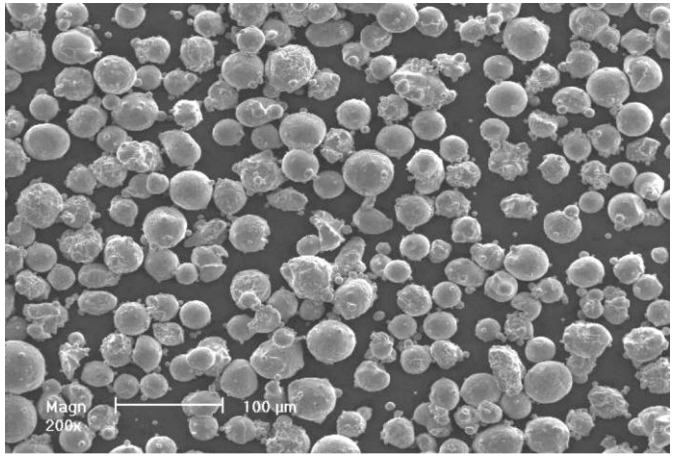
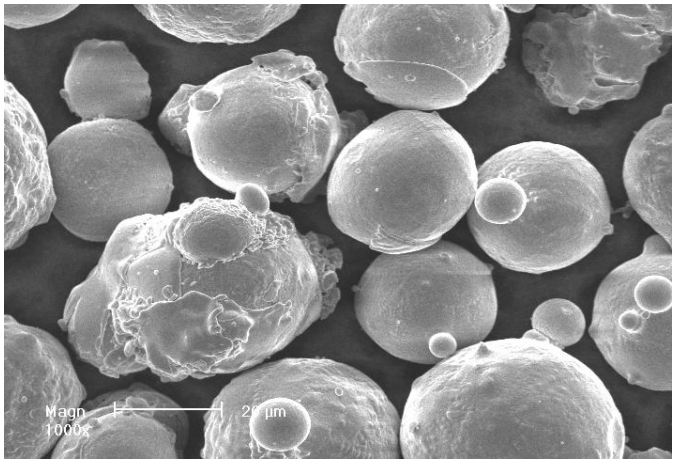
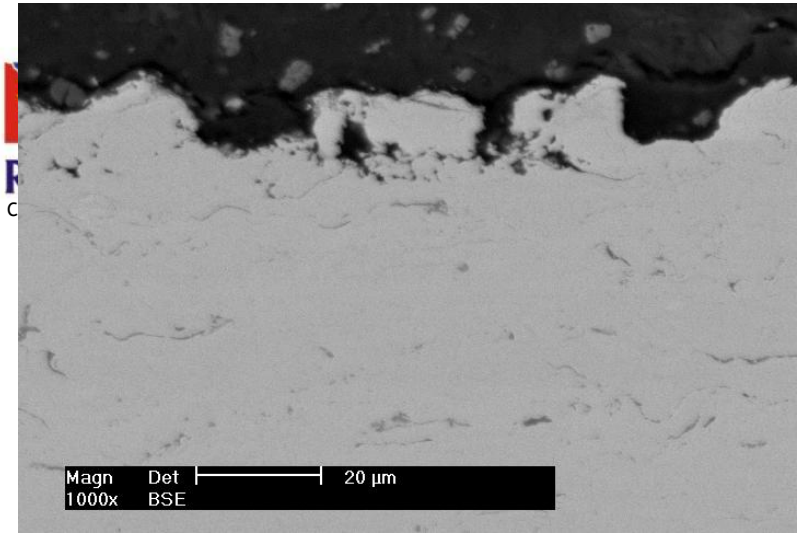
Substrate - Ni superalloy- INCONEL 617

CoNiCrAlY	Co	Ni	Cr	Al	Y
8 %Al	37.5	32	22	8	0.5
12 %Al	30.75	26.25	30.2	12	0.8
15 %Al	25.5	21.8	36.8	15	0.9

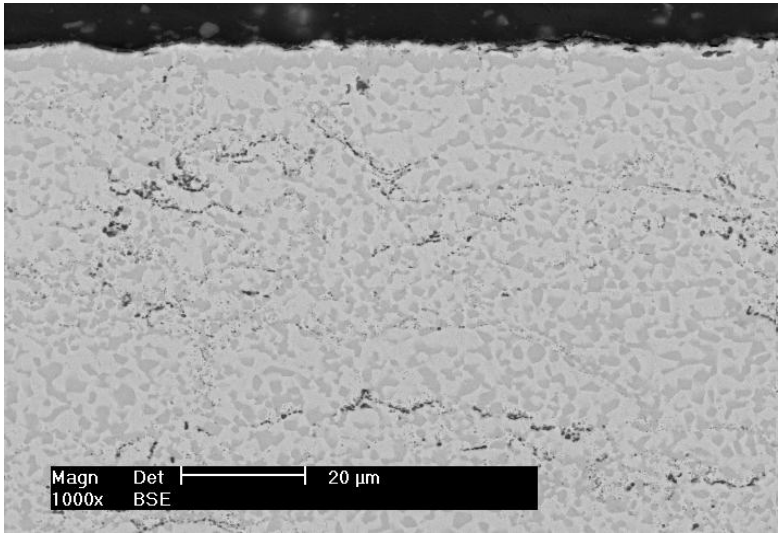




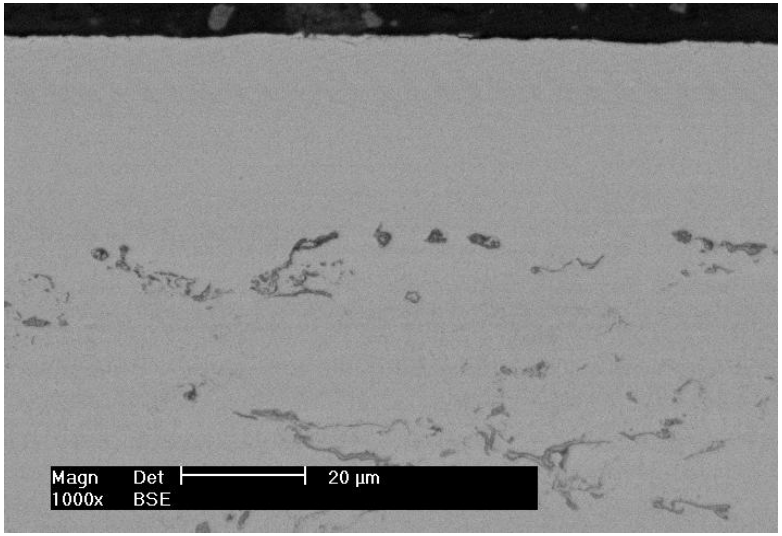
SEM micrographs of the CoNiCrAlY powder



(a)

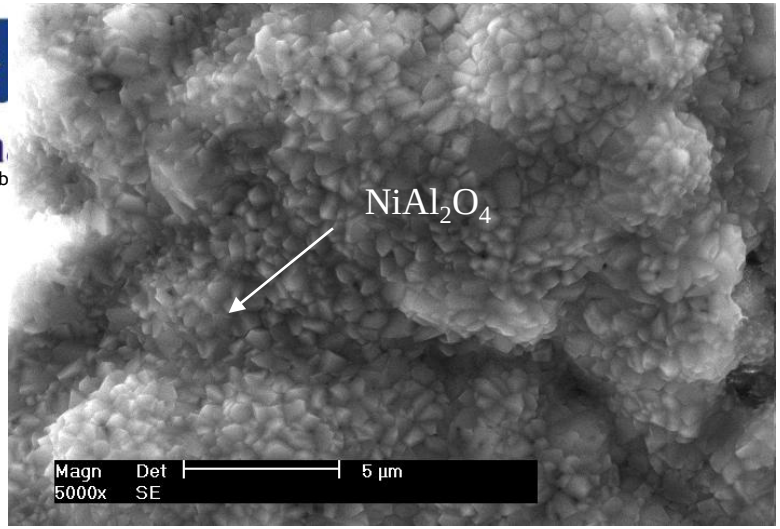


(b)

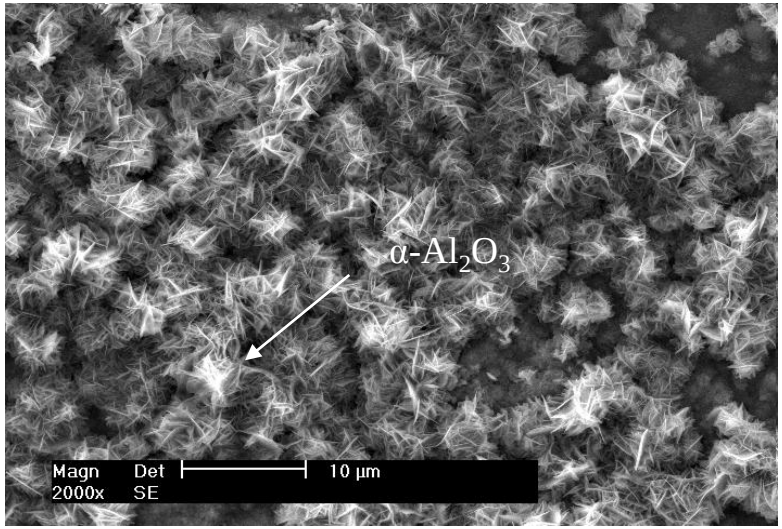


(c)

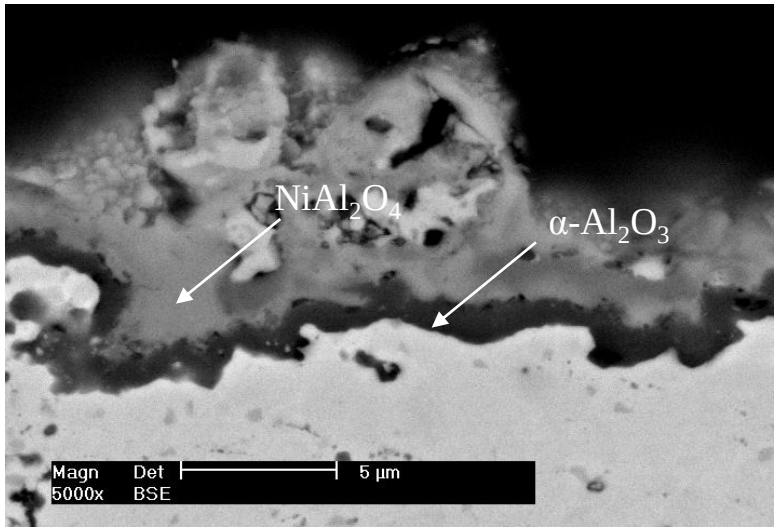
SEM micrographs of the CoNiCrAlY coating: (a) as-sprayed, (b) after the heat treatment, (c) after electron beam remelting

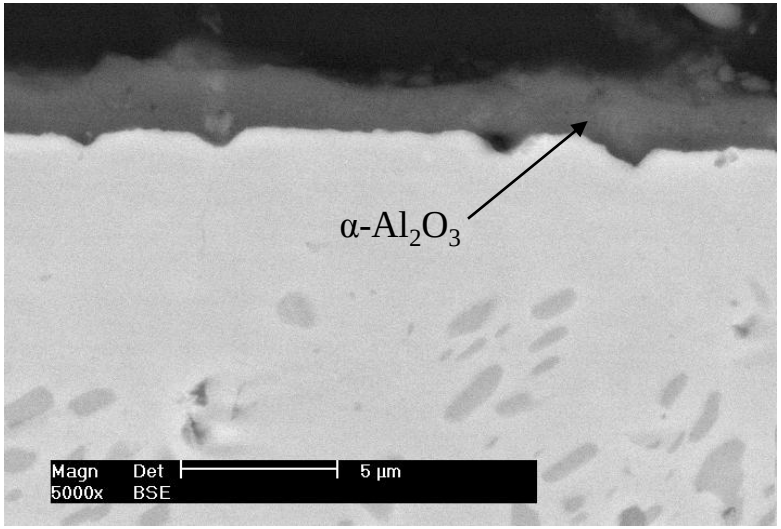


(a)

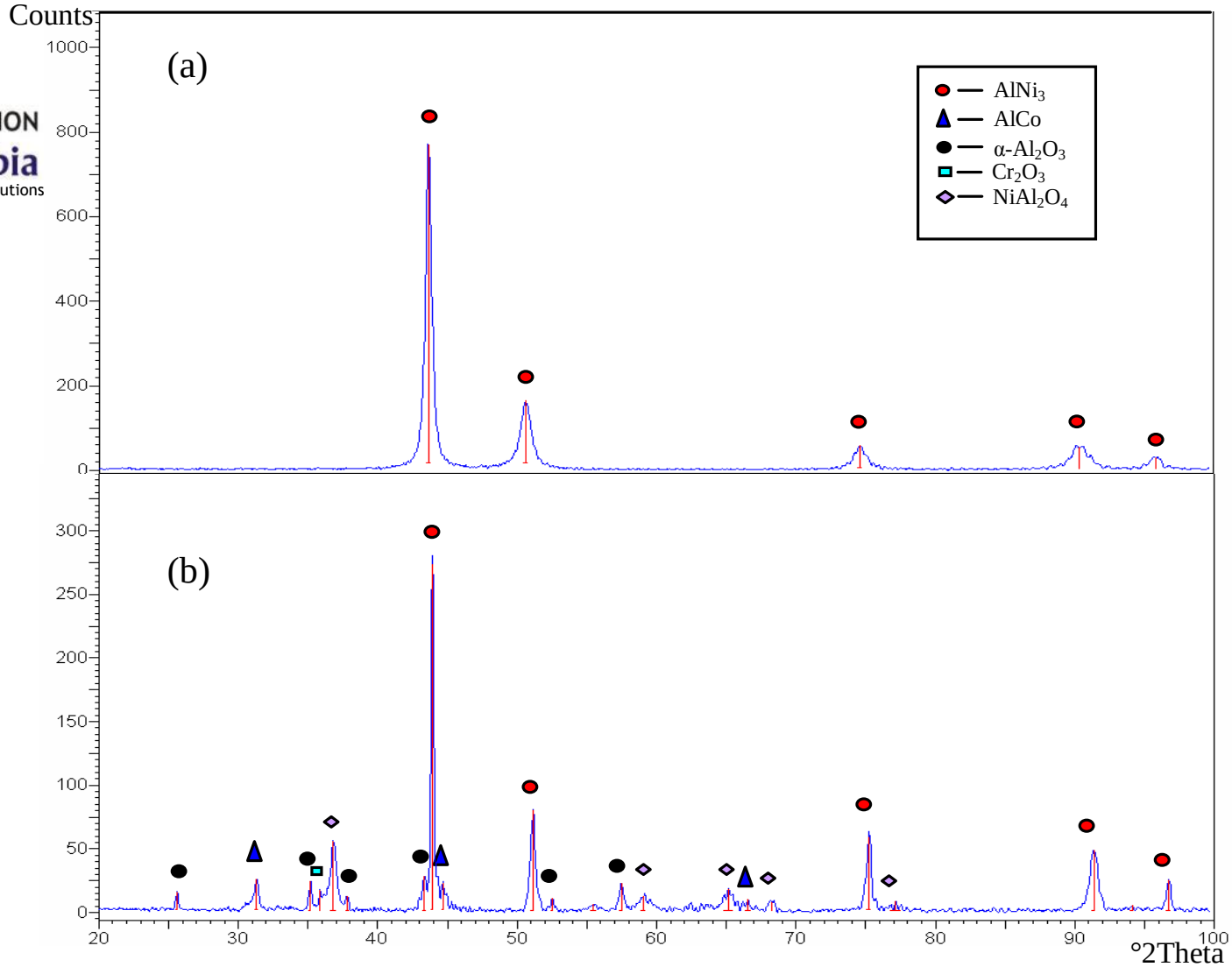


(b)

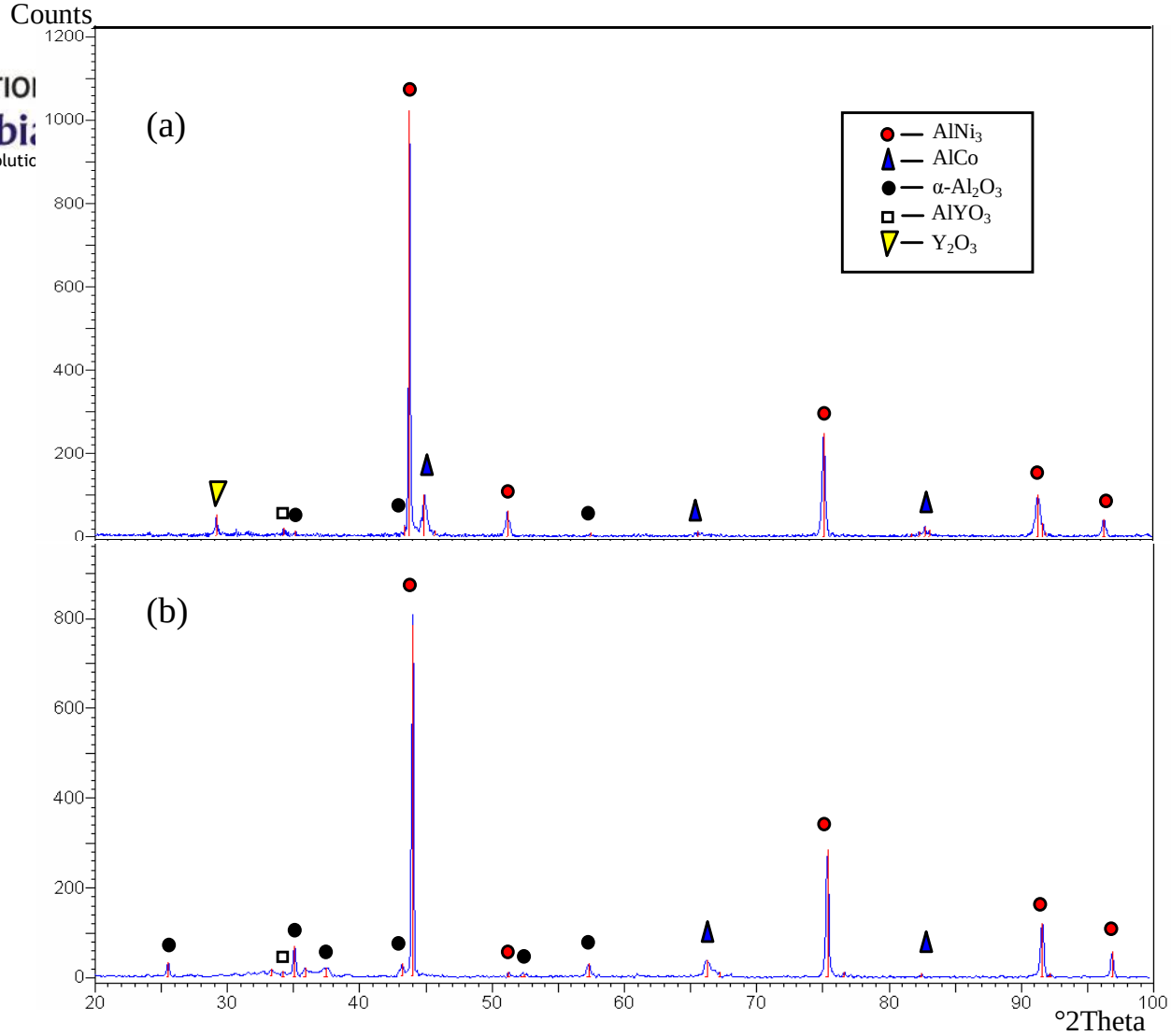




SEM images of MCrAlY coatings after oxidation at 950 C in air: as-sprayed (a) and EB beam treated (b) coatings

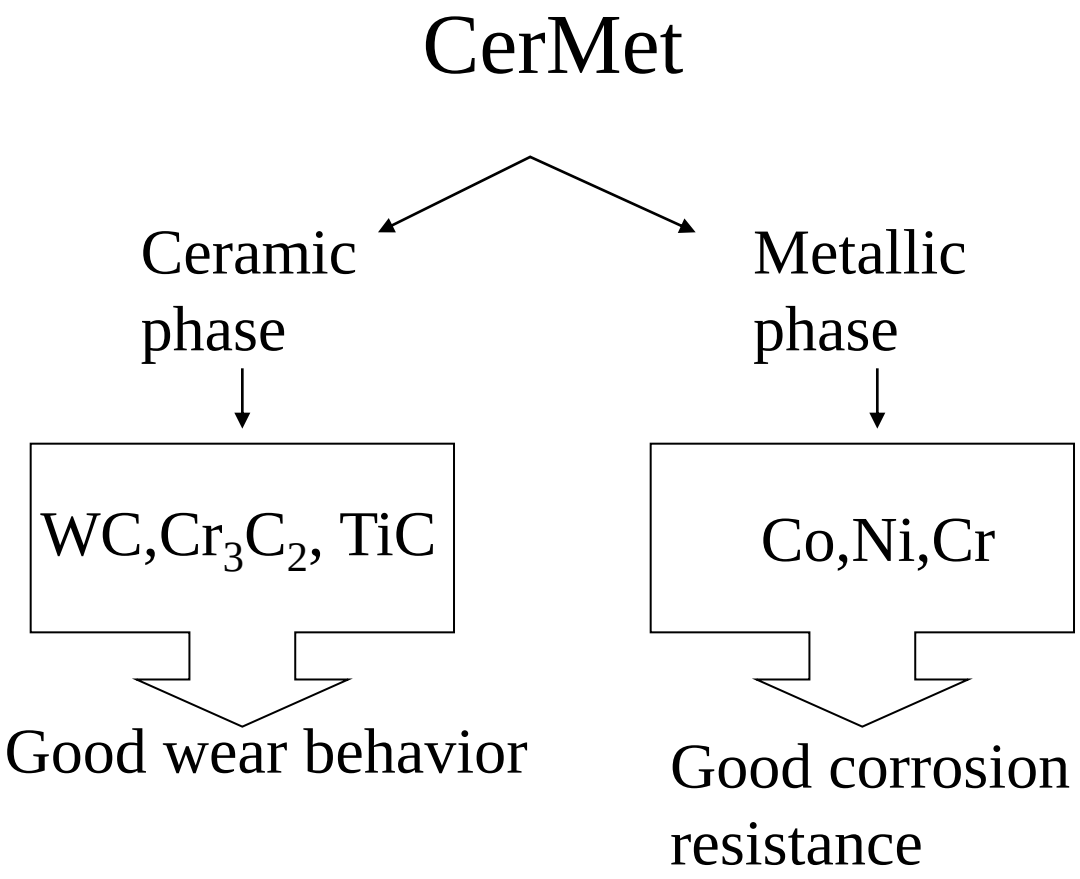


X-ray diffraction patterns of the as-sprayed coating before (a) and after oxidation at 950 C for 100 h (b)



X-ray diffraction patterns of the remelted coating before (a) and after oxidation at 950 C for 100h (b)

CERMET is a CERamic-METallic material and it is a composite coating that has ceramic particles in a metal matrix.



Cermet materials

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Cermet coatings	Properties	Application field
WC/Co; TiC_xN_1/Mo	Wear resistance, high temperature resistance	Cutting tools and processing devices
Al_2O_3/Al; Al/SiC	Wear and breaking resistance; stiffness	Pistons, disc brake, bearings, crankshafts
Al_2O_3/Ni-Co	High temperature resistance	Parts of shuttle engines, planes and helicopters

Characteristics and application fields of cermet coatings

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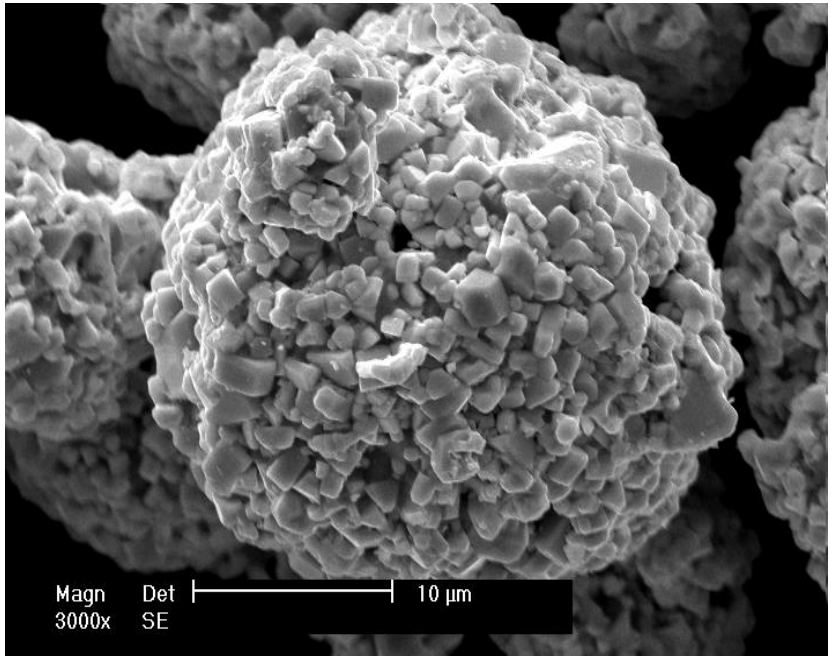
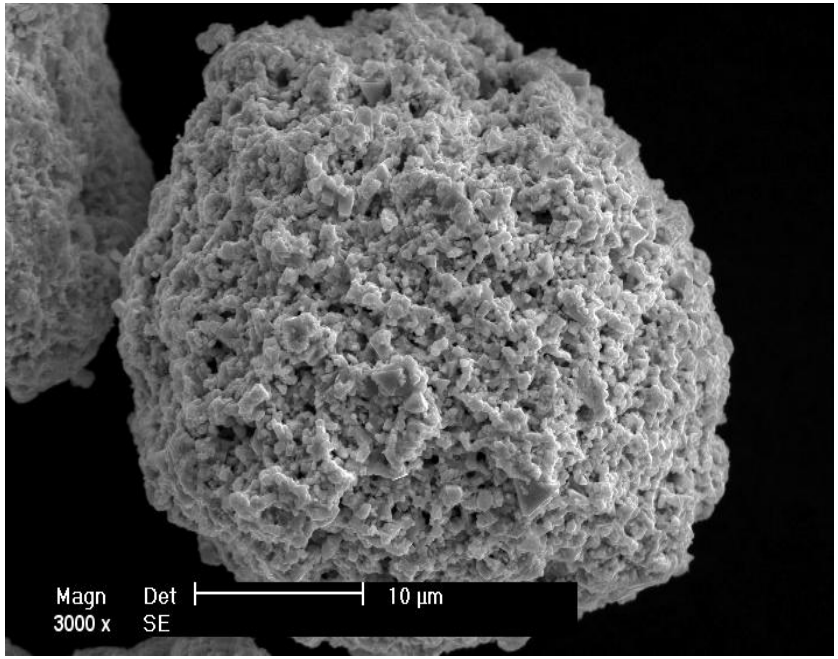
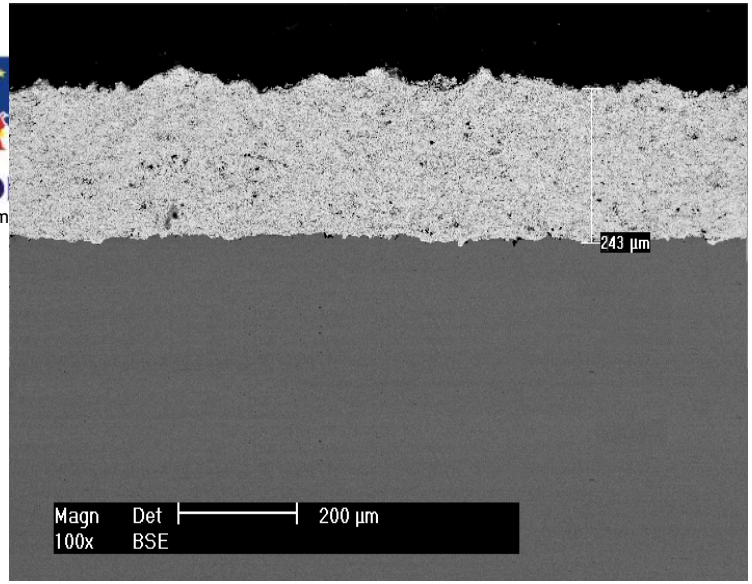
Information about the feedstock powders

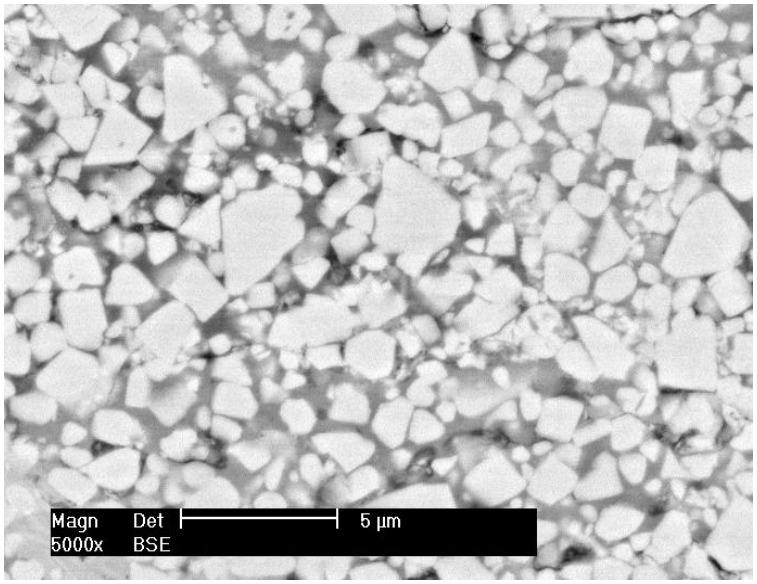
No	Chemical composition	Powder particle size range [μm]	WC grain size range [μm]
1.	WC Co 83 17	15-45	1-5
2.	WC Co 83 17	15-45	0,1-0,5



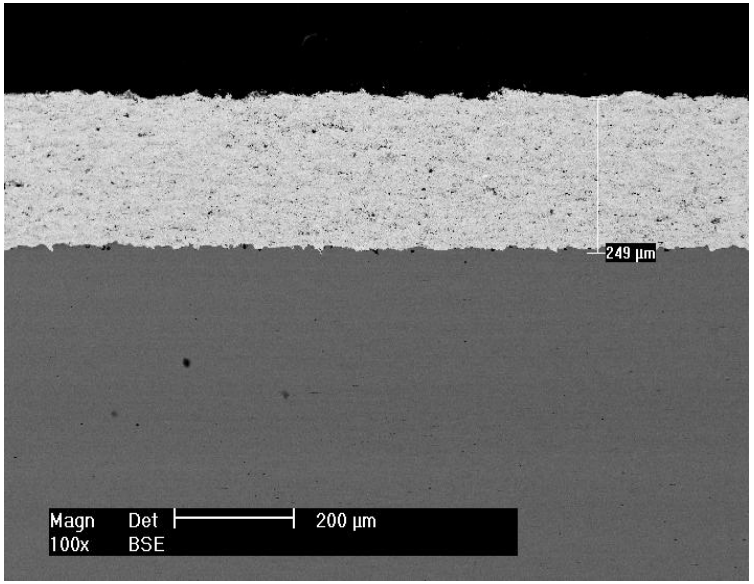


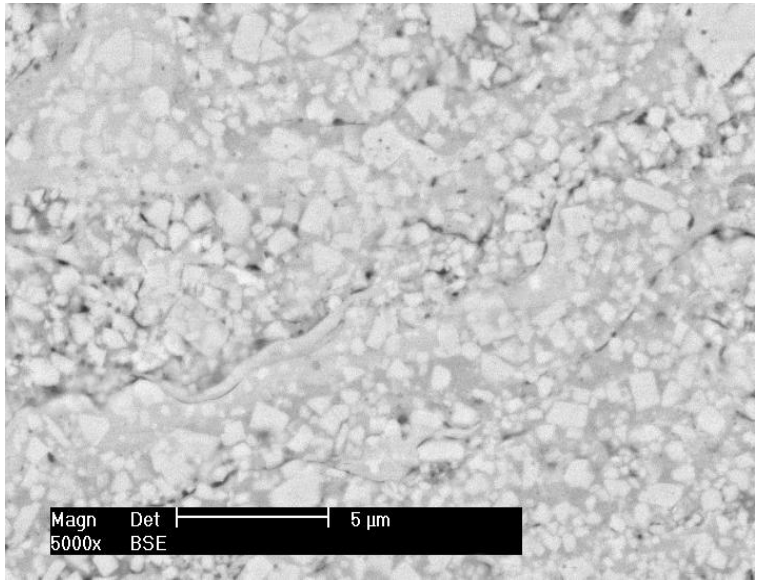
SEM micrographs of the WC-Co 83 17 powders
(a)-microscale WC-particles, (b)-nanoscale WC-particles





SEM micrographs of the WC-Co coating obtained from microscale WC-particles (sample 1)





SEM micrographs of the WC-Co coatings obtained from nanoscale WC-particles (sample 2)

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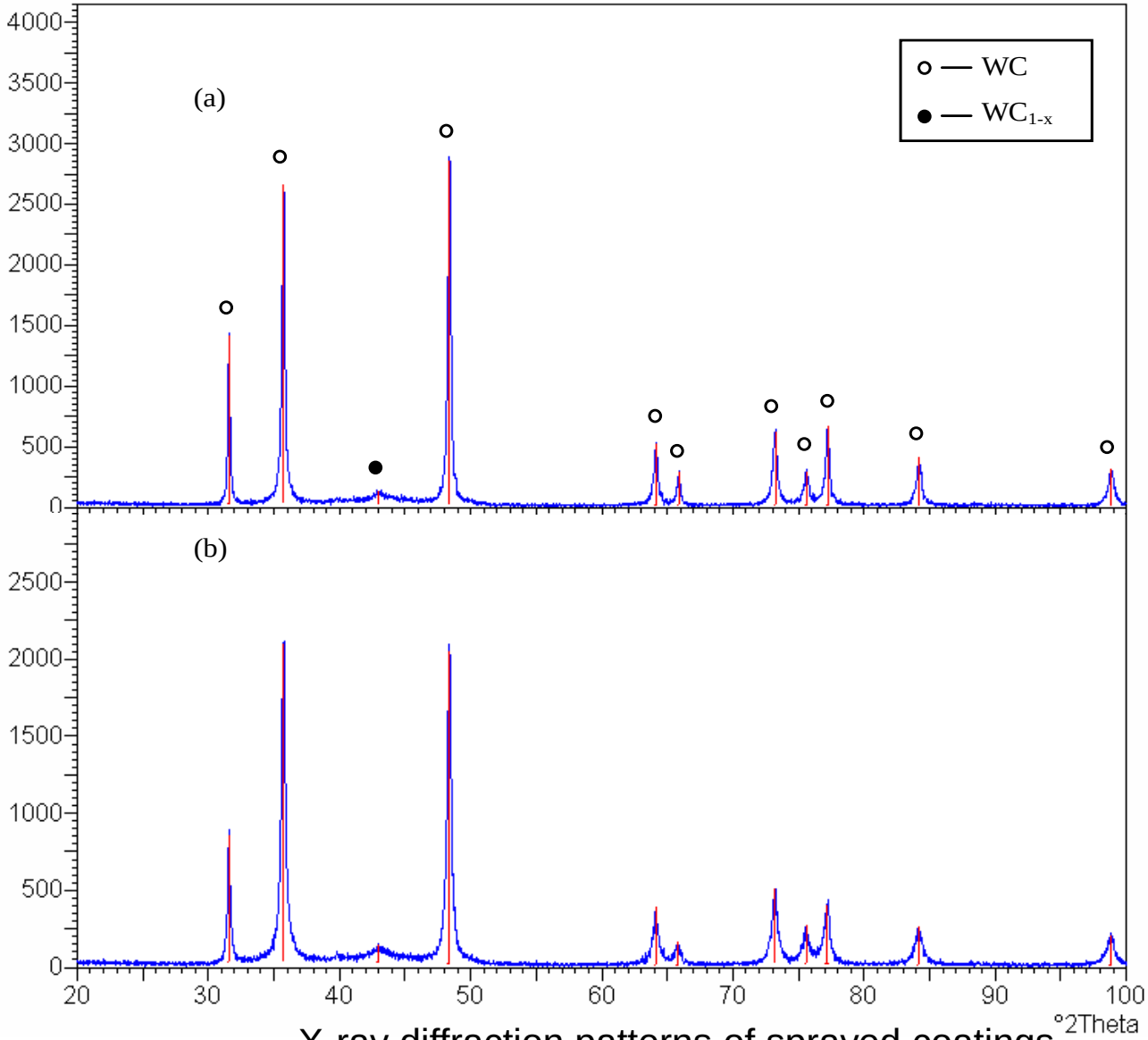
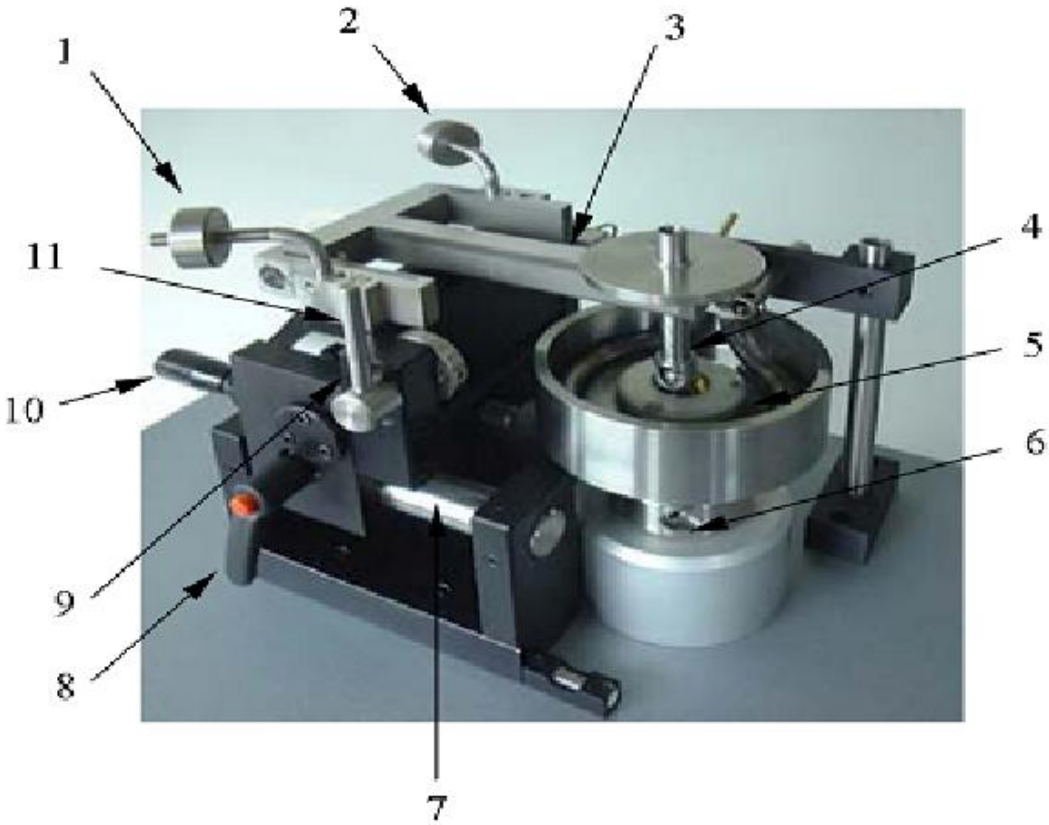
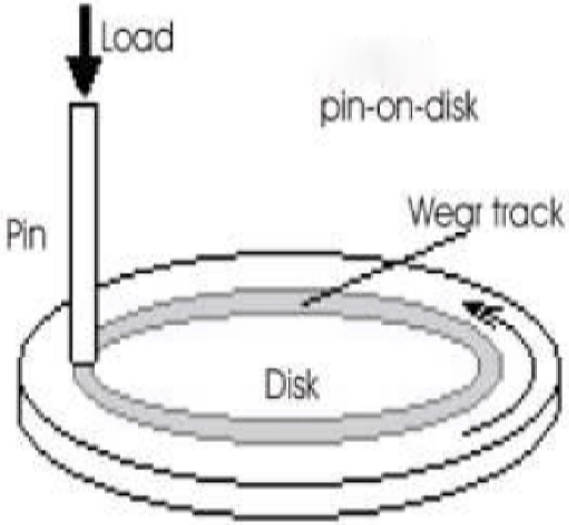


X-ray diffraction patterns of sprayed coatings
(a)-sample 1, (b)-sample 2

Wear behavior of the WC- Co coatings



CSM tribometer



Pin-on-disk method

WC ball – Φ=6mm

F = 15N, vr = 20 cm/s, d= 1000 m, R=5.4 mm

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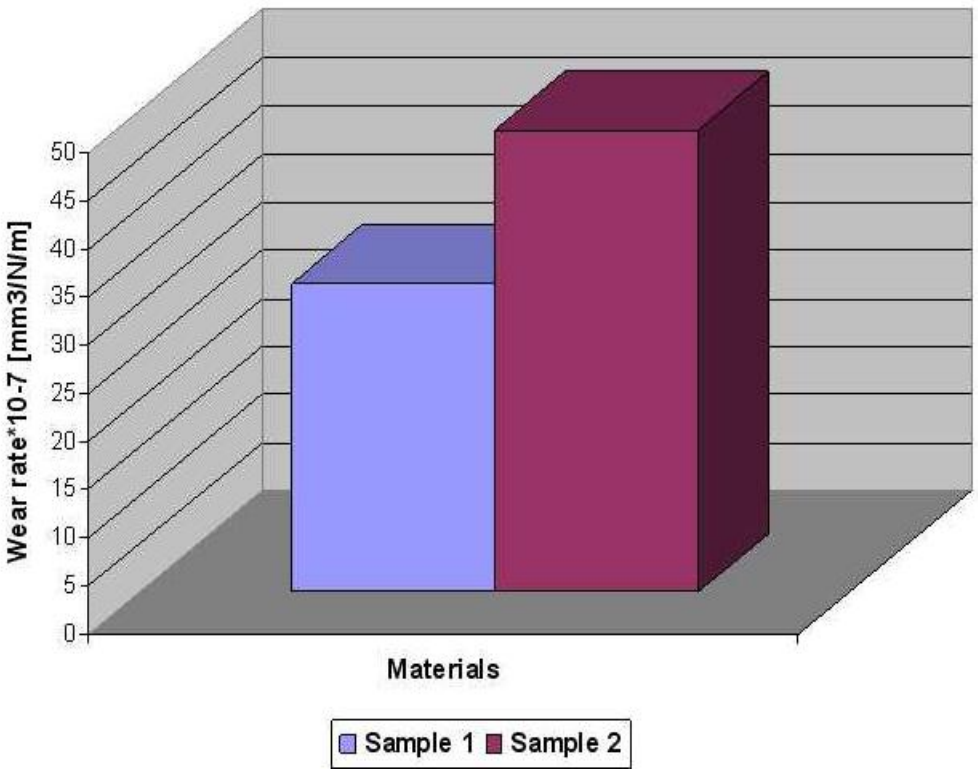
Wear rates of the tested samples

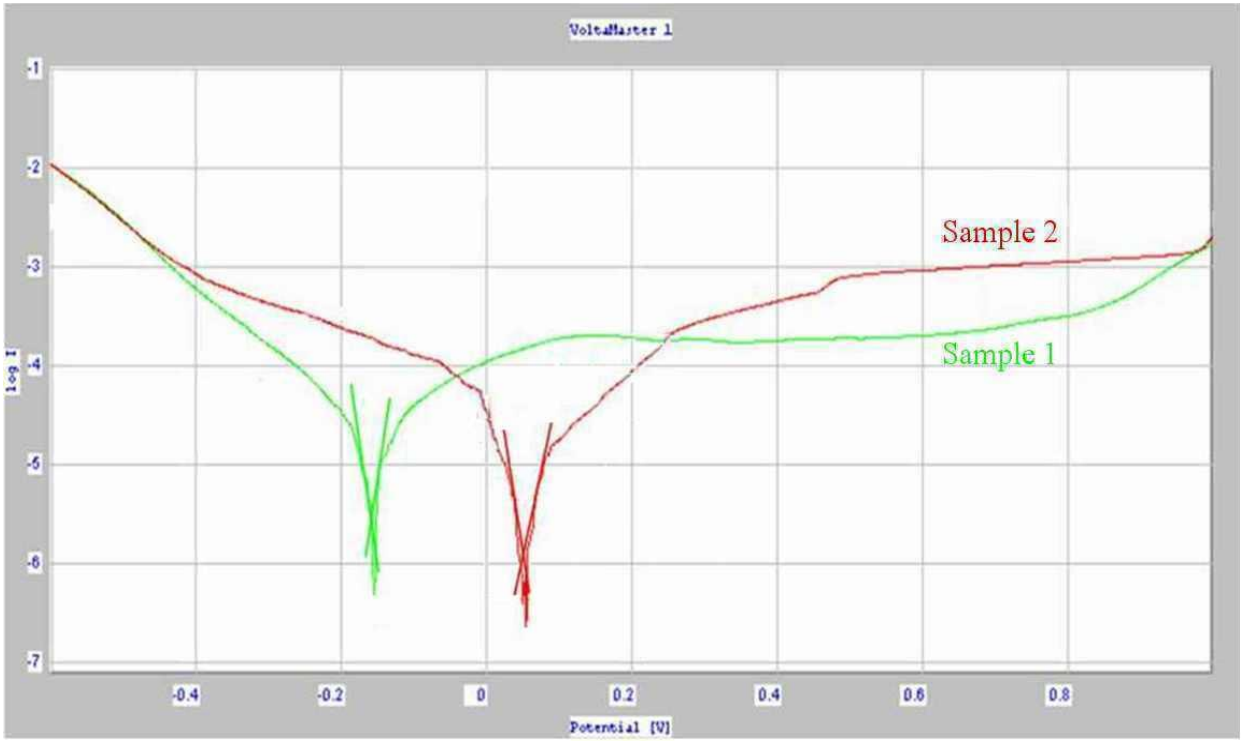
Material	Wear rate [$mm^3/N/m$]	Wear rate$_*10^{-7}$ [$mm^3/N/m$]
Sample 1	0.0000032	32
Sample 2	0.0000048	48



Sliding wear rates of the tested samples

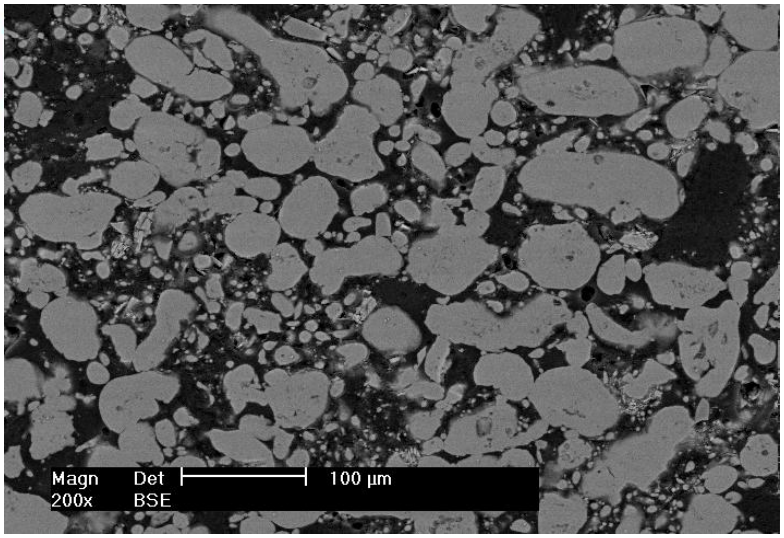
Values of the measured corrosion potential and current density

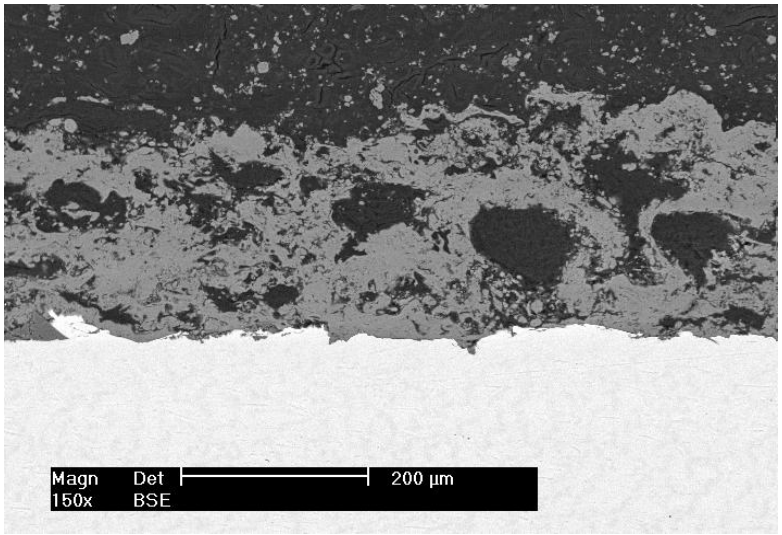
Sample	Electrochemical data	
	i_{corr} (mA/cm^2)	E_{corr} (mV)
1	0.0245	- 154,6
2	0.0058	- 140,5



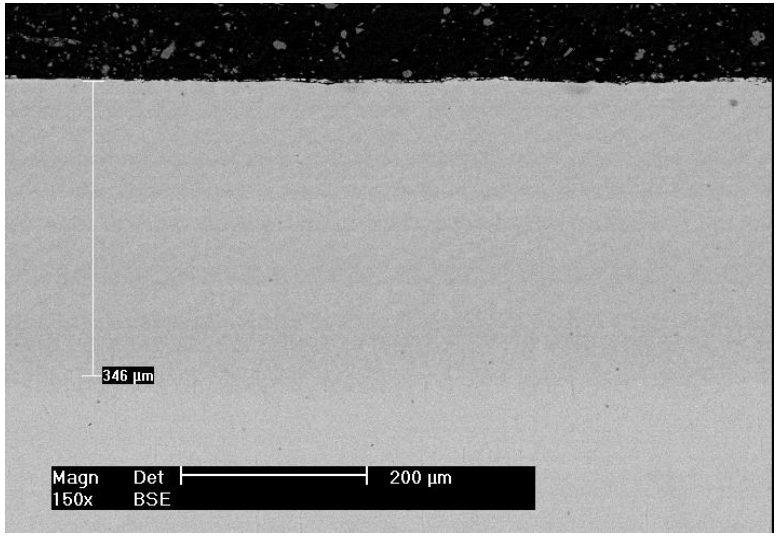
Polarization curves of the tested materials in 10^{-3} M H_2SO_4 at room temperature

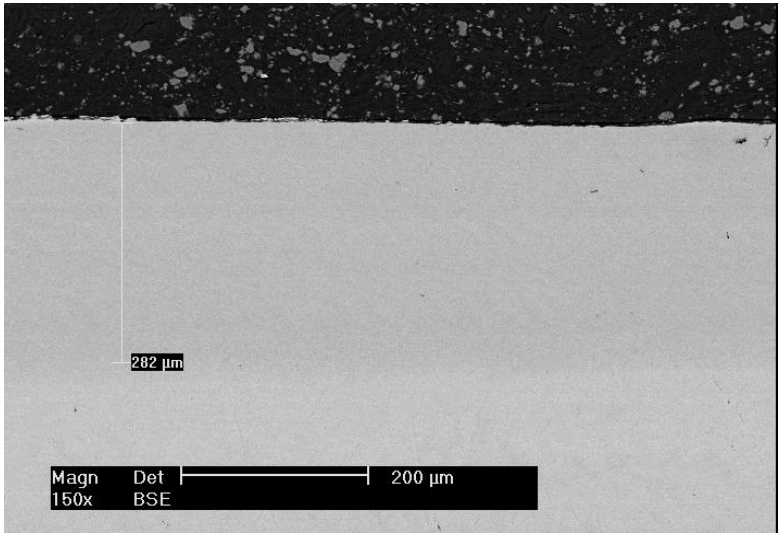
Improvement of the wear resistance of the titanium



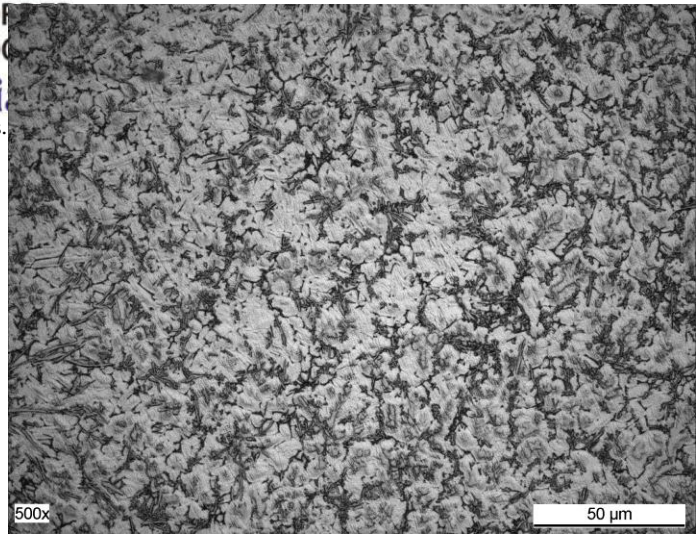


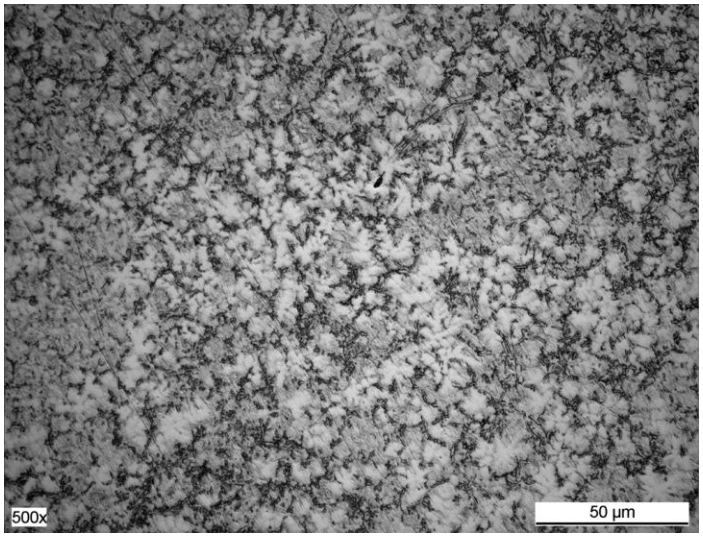
SEM micrographs of the Al8Si20BN powder and of the as-sprayed coating



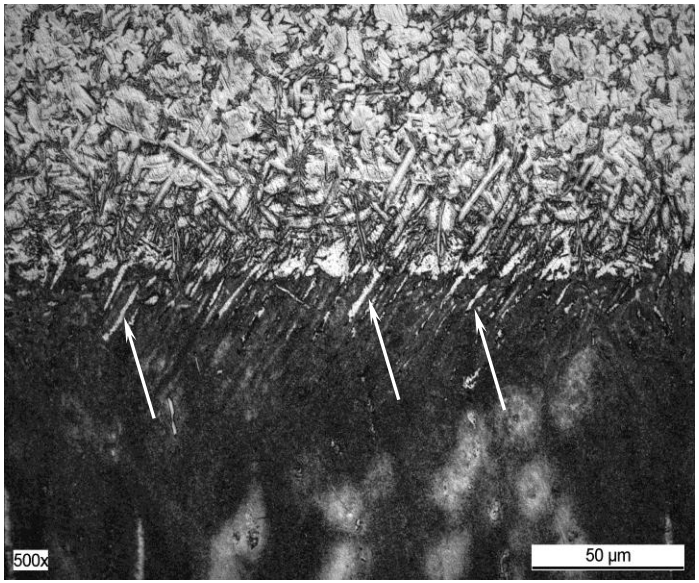


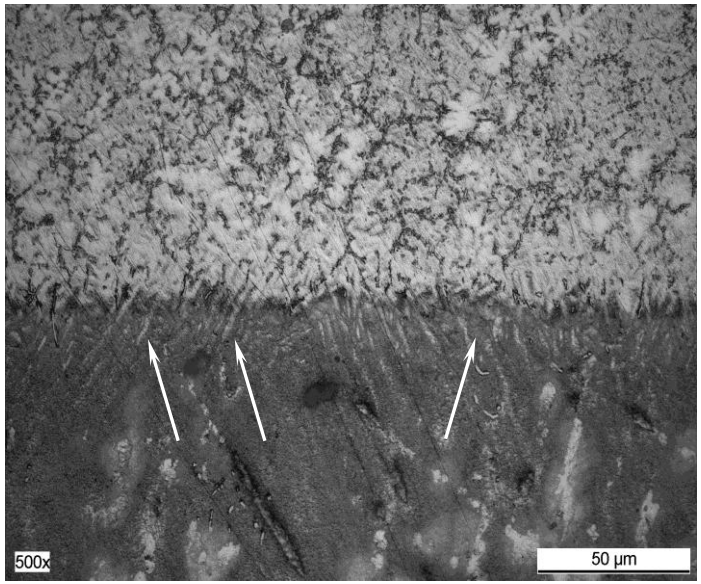
SEM micrographs of the as-sprayed and EB remelted coating

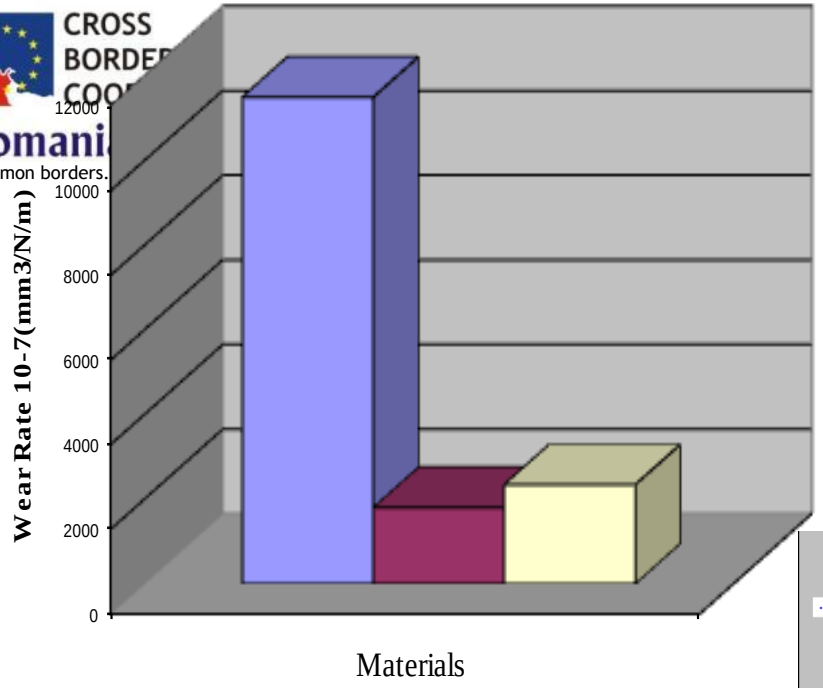




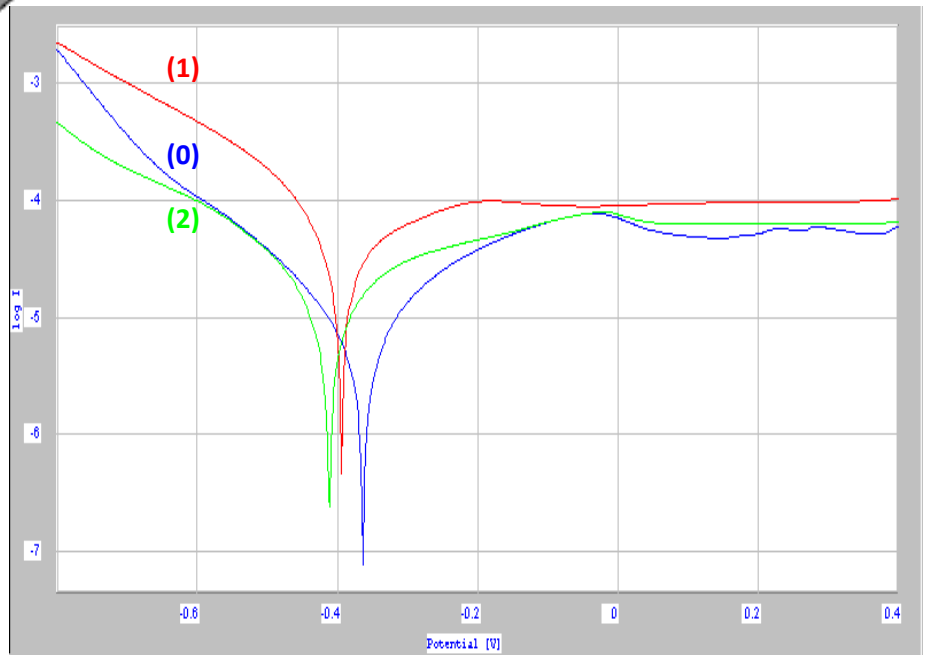
Optical micrographs of the deposited and remelted coating (surface and interface







Material	Titanium	Titanium alloyed 1	Titanium alloyed 2
HV50	130	531	447



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