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**Splat-substrate interactions in
high velocity thermal spray coatings**

by
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Abstract

Thermal spray coatings applied with high velocity techniques produce dense, industrial quality coatings with strong adhesion and minimal decomposition. This thesis reports on investigations of splat-substrate interactions for both solid and molten splats. Specifically, individual particles were studied to see how the particle is altered during the spray coating process, how they bond to the substrate and the role of surface oxides.

Investigations of NiCr particles high velocity air fuel (HVOF) thermally sprayed onto different materials found that soft substrates predominantly had deeply penetrating solid particles, whereas harder substrates resisted particle penetration and had a higher percentage of molten splats. This effect is caused by particle kinetic energy converted into heat during plastic deformation. The percentage of particle kinetic energy converted into heat is proportional to substrate hardness. It was also discovered that during the coating process the oxide is not removed or altered in composition, but becomes redistributed over a larger surface area due to the plastic deformation of the substrate. During this process, small scale redistribution and penetration of the oxide material by the incoming particle occurs. These results support the idea that successful bonding can occur only when the surface oxide on the substrate and on the coating material has been disturbed (for solid splats) or disrupted (for molten splats).

To date, our knowledge of solid splat bonding processes within thermal spray coatings has been very subjective where mechanical and chemical bonding has been expected to contribute. In this thesis, the splat-substrate interface was investigated with focused ion beam (FIB) microscopy, cross-sectional SEM and cross-sectional TEM. For solid NiCr splat HVOF coatings, the discovery of interfacial formations, together with no evidence of chemical bonding across the particle-substrate interface suggest that mechanical bonding is the dominant bonding mechanism for solid splat coatings; where as chemical bonding only plays a role when splats and/or substrate become molten.

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Contents

Abstract	i
Acknowledgements	ii
Chapter 1. Introduction.....	1
Chapter 2. Literature Review.....	3
2.1. Thermal Spray – introduction.....	3
2.2. Thermal spray techniques	5
2.2.1. Cold Spray	7
2.2.2. Combustion: HVOF, HVOF, HVOF	8
2.2.3. Plasma	14
2.2.4. Electric/Wire arc.....	15
2.3. Coating Structure.....	16
2.4. Interfacial bonding	21
2.4.1. Solid Particle Coatings	21
2.4.2. Molten particles	22
2.5. Effect of surface oxide layers in solid splat coatings.....	25
2.6. Oxidation during the thermal spray process	27
2.7. Summary of literature review and identification of the gaps in knowledge	28
Chapter 3. Experimental Methodologies: Sample Preparation and Surface Analysis	29
3.1. Introduction.....	29
3.2. Thermal spray experiments	30
3.3. HVOF thermal spray	31
3.4. HVOF thermal spray.....	31
3.5. Substrate materials.....	32
3.6. Methodologies	34
3.6.1. Focussed Ion Beam (FIB)	34
3.6.2. Transmission Electron Microscopy (TEM).....	43
3.6.3. Scanning Electron Microscopy (SEM).....	46
3.6.4. Ion Beam Analysis (IBA)	50
3.6.5. X-ray photoelectron spectroscopy (XPS).	59
3.7. Bulk analysis of NiCr powder and coatings.....	61
3.8. Surface analysis of NiCr powder and coatings	64
3.9. Summary	72

Chapter 4.	Influence of Substrate Properties on Splat Formation.....	73
4.1.	Introduction.....	73
4.2.	Experimental.....	74
4.3.	Results.....	75
4.4.	Discussion	85
4.4.1.	Heat gained during acceleration in the HVAF gun	86
4.4.2.	Kinetic energy converted into heat during impact.....	87
4.4.3.	Adiabatic heating.....	87
4.4.4.	Relationship between temperature and energy.....	90
4.4.5.	Percentage of solid and molten splats	93
4.5.	Conclusion.....	95
Chapter 5.	Interfacial Bonding of Solid NiCr Splats.....	96
5.1.	Introduction.....	96
5.2.	Aluminium substrates	97
5.3.	Copper substrates	104
5.4.	Steel substrates.....	109
5.5.	Conclusions.....	111
Chapter 6.	Influence of Oxide Layers on Splat Bonding	113
6.1.	Introduction.....	113
6.2.	Experimental.....	114
6.3.	Results and Discussion	118
6.3.1.	Hydrothermal oxide coating	118
6.3.2.	Electrochemically grown oxide coating	121
6.4.	Analysis and discussion.....	125
6.4.1.	Solid splat-substrate interface.....	127
6.4.2.	Molten splat-substrate interface	134
6.4.3.	3D reconstruction of a molten splat.....	137
6.5.	Conclusions.....	141
Chapter 7.	Conclusions	142
7.1.	Introduction.....	142
7.2.	Characterisation of powder and coating	142
7.3.	Effect of substrate hardness on splat formation.....	143
7.4.	Interfacial bonding of solid NiCr splats.....	143
7.5.	Effect of oxide layer during splat bonding.....	144
7.6.	Key Results	145
7.7.	Implications of thesis findings	146

References.....	147
Appendix 1. Sample preparation methods	156
A1.1. Introduction.....	156
A1.2. Cross-sectional SEM sample preparation.....	156
A1.3. Cross-sectional TEM sample preparation.....	160
A1.3.1 Ion Beam Thinning	161
A1.3.2 Ultramicrotomy	162
A1.3.3 Tripod polishing.....	164
A1.3.4 FIB.....	167
Appendix 2. Phase Diagrams.....	173
A2.1. The Ni-Cr Binary System.....	173
A2.2. The Al-Ni Binary System.....	175
Appendix 3. Experimental Equipment.....	176
Appendix 4. Surface Analysis Methods	182
Appendix 5. Interfacial Bonding of Solid NiCr Splats.....	185
Appendix 6. Influence of Oxide Layers on Splat Bonding	188
Appendix 7. Effect of Particle/Substrate Heating.....	200
A7.1. Introduction.....	200
A7.2. Experimental.....	201
A7.2.1 HVOF thermal spray.....	201
A7.2.2 Preheated substrates	203
A7.3. Splat-substrate interface investigations	212
A7.3.1 HVOF thermal spray.....	212
A7.3.2 HVAF onto preheated Al substrates	222
A7.4. Discussion	227
A7.4.1 Splashing orthogonal to the substrate surface	227
A7.4.2 Interfacial bonding with oxides	228
A7.4.3 Diffusion / Chemical reactions.....	229
A7.5. Conclusions	231
Appendix 8. Publications	233

List of Figures

Figure 2-1: General thermal spray process.	5
Figure 2-2: Diagram of cold spray and thermal spray processes.....	6
Figure 2-3: Plot of particle velocity versus particle temperature for cold spray and thermal spray processes.....	6
Figure 2-4: Schematic of a typical cold-gas dynamic-spray system	8
Figure 2-5: HVAF thermal spraying Browning Aerospray gun (150 model) at Holsters Engineering Tokoroa NZ..	9
Figure 2-6. Schematic illustrations of the most common HVOF and HVAF thermal spray systems.....	11
Figure 2-7: Particle velocity distributions for HVOF thermal spray.	13
Figure 2-8: Laser velocimeter 2-D Particle velocity distributions for HVOF thermal spray .	13
Figure 2-9: Schematic representation of a plasma spray gun	14
Figure 2-10: Schematic representation of the wire-arc spray process	15
Figure 2-11: Schematic microstructure of a thermal spray coating.	16
Figure 2-12: Variation of the adhesive strength of the coating with substrate temperature ...	18
Figure 2-13: Schematic of splat formation. (a) disk-splat $T_t < T_s$, (b) splash-splat $T_t > T_s$...	19
Figure 2-14: Splashing at impact of alumina droplets impacting on a hot stainless steel substrate preheated at 600K with (a) $K=139$, (b) $K=229$, (c) $K=776$, and (d) $K=1346$.	20
Figure 3-1: Schematic and diagram of a FIB column.....	35
Figure 3-2: Picture and diagram of a gallium Liquid Metal Ion Source (LMIS)	36
Figure 3-3: Ion Beam / sample interactions.	37
Figure 3-4a: Increased material contrast in the ion image reveals compositional information unavailable using electron imaging.	39
Figure 3-4b: Increased material contrast in the ion image reveals compositional information unavailable using electron imaging	39
Figure 3-5: FIB Channelling observed in NiCr HVAF spray coatings. FIB images were taken at three different tilt angles (20° , 29.2° and 45°).	40
Figure 3-6: FIB milled cross-section image with an ion beam.....	41
Figure 3-7 Schematic of a TEM.....	44
Figure 3-8: Schematic of beam interactions in a TEM	44
Figure 3-9: Bragg scattering and scattering geometry.	45
Figure 3-10: Schematic representation of the electron beam interactions with solid matter..	47
Figure 3-11: Illustration showing the interaction volume for 20 kV electrons in a nickel ($Z=28$) specimen.	47
Figure 3-12: Energy spectrum of emitted electrons.....	48
Figure 3-13: Schematic illustration of elastic and inelastic collisions at different velocities and distances of closest approach.	50

Figure 3-14: The ion beam loses energy as it penetrates a sample depending on the material's stopping power. In addition, the reaction products will also lose energy as they travel back out of the material.....	51
Figure 3-15: X-ray spectra of a NiCr alloy powder from both PIXE and EDAX..	53
Figure 3-16: Nuclear reaction spectra of native oxides on the surface of substrate materials used in this study.....	55
Figure 3-17: Diagram illustrating energy loss and the method of depth profiling.	56
Figure 3-18: ERDA spectra plus SIMNRA simulations of oxidised aluminium samples and a mylar film.....	58
Figure 3-19: XPS experimental setup	59
Figure 3-20: NiCr powder particles stuck on carbon tape and sectioned using FIB	61
Figure 3-21: EDS Elemental maps of NiCr powder	62
Figure 3-22: EDS Elemental maps of NiCr coating	62
Figure 3-23: X-ray spectra from NiCr powder and HVOF thermally sprayed coatings.	63
Figure 3-24: NRA spectra using a 1.6 MeV deuteron beam.....	65
Figure 3-25: NRA spectra measured with a broad beam of 900 keV deuterons to utilise the $^{16}\text{O}(d,\alpha_0)^{17}\text{O}$ reaction.	65
Figure 3-26: $^{28}\text{Si}(d,p_0)^{29}\text{P}$ spectra of the NiCr powder and the NiCr particle measured with a deuteron energy of 2.75 MeV.	67
Figure 3-27: Si depth profile of: NiCr HVOF spray coating and a Si wafer.....	68
Figure 3-28: Ni depth profiles of: NiCr HVOF spray coating, NiCr raw powder and a Ni standard.....	69
Figure 3-29: Cr depth profiles of: NiCr HVOF spray coating, NiCr raw powder and a Cr standard	69
Figure 3-30: Wide XPS scan of a NiCr coating. Narrow XPS scans for Ni and Cr from a NiCr coating are shown in the inset.....	71
Figure 4-1a: Solid splats, HVOF sprayed with NiCr particles on various substrates.....	76
Figure 4-1b: Semi-molten splats, HVOF sprayed with NiCr particles on various substrates.	76
Figure 4-1c: Molten-splash splats, HVOF sprayed with NiCr particles on various substrates	77
Figure 4-1d: Molten-disc splats, HVOF sprayed with NiCr particles on various substrates..	77
Figure 4-2: The graph demonstrates that there is a strong relationship of splat type percentage with substrate hardness..	79
Figure 4-3: Diagram illustrating the dimensions used to calculate the particle compression and flattening ratios.....	80
Figure 4-4: A plot of particle flattening ratio (splat diameter / pre-impact particle diameter) versus substrate hardness... ..	80
Figure 4-5: Solid splat diameter versus substrate hardness. Solid splat diameters show no correlation with substrate hardness.....	82
Figure 4-6: Molten splat diameters versus substrate hardness. Molten splat diameters are larger on harder substrates.. ..	82

Figure 4-7: Plot of crater volume / splat volume ratio versus hardness.....	84
Figure 4-8: Particle flattening ratio (splat diameter / pre-impact particle diameter) versus average grain size.....	84
Figure 4-9: Thermal diffusion distance (X_D) of some materials used in this study.....	88
Figure 4-10: Relationship between the splat thermal energy and temperature.....	91
Figure 4-11 a) The pre-impact thermal distribution with an average velocity of 670 ms^{-1} and 0% of the KE transferred into heat. b) The splat thermal distribution with an average velocity of 670 ms^{-1} and 90% of the KE transferred into heat. c) The splat thermal distribution with an average velocity of 975 ms^{-1} and 90% of the KE transferred into heat.....	92
Figure 5-1: Secondary electron images of three different solid NiCr splats embedded in Al substrates, sectioned and imaged with a FIB.....	98
Figure 5-2: Cross sectional SEM images of semi-molten NiCr splats embedded in an Al substrate with varying degrees of interfacial contact and interfacial turbulence: a) low level of interfacial turbulence, b) medium level of interfacial turbulence, and c) high level of interfacial turbulence.	99
Figure 5-3: TEM images of a $12 \mu\text{m}$ NiCr splat embedded in an aluminium substrate; a) bright field image of interface with a smaller image of the whole splat showing the location of the interface images, b) Al elemental map and c) Ni elemental map.....	100
Figure 5-4: Graph of bonding feature size versus splat diameter shows that larger splats have larger bonding features.	102
Figure 5-5: Cross sectional FIB image of NiCr splats embedded in copper substrates.....	105
Figure 5-6: Bright field TEM image at the Cu substrate – NiCr splat interface. The plastically deformed surface scrubbing jet is shown at the splat-substrate interface.....	106
Figure 5-7: Three EDS line scans measured across the Cu substrate-Cu jet-NiCr splat interface.....	107
Figure 5-8: Bright field TEM image and selected area diffraction patterns at the splat-substrate interface region.	108
Figure 5-9: Cross sectional FIB images of a NiCr splat HVOF thermally sprayed onto a steel substrate..	109
Figure 5-10: Cross sectional SEM images of individual NiCr splats HVOF thermally sprayed onto a steel substrate..	110
Figure 6-1: FIB sectioned hydrothermally grown oxidised aluminium sample with a oxide layer thickness of $845 \pm 67 \text{ nm}$	115
Figure 6-2: A secondary electron FIB overview image of an aluminium substrate containing a hydrothermal oxide, thermally sprayed with NiCr particles using the HVOF technique..	118
Figure 6-3: Secondary electron FIB images of “indents” a, b and c (particle impact damage) on an aluminium substrate with a hydrothermal oxide, thermally sprayed with the HVOF technique..	119
Figure 6-4: Elemental analysis of an overview area of an aluminium substrate containing a hydrothermally grown oxide layers thermally sprayed with NiCr particles using the HVOF technique.	120

Figure 6-5: A FIB secondary electron overview image of bonded NiCr splats on an electrochemically grown oxide, thermally sprayed with the HVAF technique.....	121
Figure 6-6: An indent in the oxidised aluminium substrate, thermally sprayed with NiCr particles using the HVAF technique. The oxide was grown electrochemically.....	122
Figure 6-7: A selection of solid NiCr splats thermally sprayed using the HVAF technique onto aluminium substrates with an electrochemically grown oxide layer.....	123
Figure 6-8: Semi-molten (a and b) and molten (c and d) NiCr splats thermally sprayed using the HVAF technique onto aluminium substrates with an electrochemically grown oxide layer.....	124
Figure 6-9: Splat type percentages for the electrochemically grown oxide layer are compared to the splat type percentages on other Al substrate materials.....	127
Figure 6-10a: A 15 μm diameter NiCr splat bonded to the electrochemical oxidised Al substrate. a) 15 μm particle, b) FIB section, c) TEM bright field image and d) a higher magnification image at the interface near the side of the splat.....	130
Figure 6-10b: Elemental line scans across the oxide at two different locations at the splat-substrate interface of the 15 μm diameter splat.....	130
Figure 6-11: a) A FIB image of a sectioned bonded 35 μm NiCr particle on the electrochemical aluminium oxide and b) a higher magnification image of the interface.....	131
Figure 6-12: TEM image and elemental maps of a 35 μm particle bonded to the aluminium substrate electrochemically oxidized.....	131
Figure 6-13: TEM image and elemental maps of a splat-substrate interface region.....	132
Figure 6-14: a) Bright field image with the location of the line scan measurements indicated b) and c) elemental line scans across the splat-substrate interface in a region indicated in Figures 6-12 and 6-13.....	133
Figure 6-15: FIB images of, a) a whole molten splat and b) a sectioned molten splat.....	135
Figure 6-16: Elemental maps of the sectioned molten particle and the substrate shown in Figure 6-15.....	136
Figure 6-17: SEM image of a molten splat.....	138
Figure 6-18: 3D reconstructed images: Overview.....	140
Figure A1-1: Diagram showing an example of where a sample is sectioned for a cross-sectional sample.....	157
Figure A1-2: A low speed diamond saw and a band saw that were used to section samples.....	157
Figure A1-3: Diagram showing how a sample is positioned in an epoxy mould for cross-sectional polishing.....	157
Figure A1-4: Polished cross-sectioned samples (37 mm and 25 mm in diameter).....	158
Figure A1-5: 130 μm diamond cut wheel for rough grinding.....	159
Figure A1-6: Automated Logitech LP30 lapping machine for fine grinding.....	159
Figure A1-7: Struers polishing machine for polishing.....	160
Figure A1-8: An ion beam thinned TEM sample of a NiCr splat on an aluminium substrate.....	161
Figure A1-9: Schematic figure of the ultramicrotome sectioning the sample.....	163

Figure A1-10: Ultramicrotome sections of a NiCr coating HVAF thermal sprayed onto a Cu substrate.	163
Figure A1-11: Scheme of sample preparation for planar view and perpendicular cross-section.	165
Figure A1-12: A tripod polished NiCr coating HVAF thermally sprayed onto an Al substrate.	167
Figure A1-13: A diagram showing the sample size and orientation.....	169
Figure A1-14: A low speed diamond saw is sectioning a 3 mm x 1 mm x 0.5 mm.....	169
Figure A1-15: The sample is then polished to thin the sample to a thickness of approximately 30 microns.....	169
Figure A1-16: a) rough cut samples glued with crystal wax to a metal mounting block then b) polished to approximately 30 μm in thickness.	170
Figure A1-17: Measuring the polished sample thickness in an optical microscope.....	170
Figure A1-18: Schematic diagram showing TEM specimen preparation using the H-type method.....	171
Figure A1-19: The thin 10-30 μm thick sample surface is mounted upwards.....	171
Figure A1-20: The sample is “thinned” by milling out sections from each side until the desired thickness is achieved. The last stages of thinning need skill and experience. .	172
Figure A2-1: Diagram of a Face-centred cubic lattice: Fm3m, cF4.....	174
Figure A2-2: The Ni-Cr equilibrium phase diagram	174
Figure A2-3: The Ni-Cr equilibrium phase diagram	175
Figure A3-1: HVAF thermal spraying at Holsters Engineering in Tokoroa, New Zealand .	176
Figure A3-2: FEI xP200 FIB at UNSW.....	177
Figure A3-3: xT Nova NanoLab 200 dual beam FIB at UNSW which combines a high resolution focused ion beam (Ga + FIB) and a high resolution scanning electron microscope.	177
Figure A3-4: The Philips CM200 field emission gun transmission electron microscope at the UNSW.....	178
Figure A3-5: Three million volt accelerator and control room at GNS science.....	179
Figure A3-6: General purpose IBA chamber at GNS Science.	180
Figure A3-7: Microprobe chamber at GNS Science.....	180
Figure A3-8: XPS: Kratos XSAM 800 at AU.	181
Figure A3-9: SEM: Philips XL 30S (FEG) at AU.....	181
Figure A4-1: Elements in an X-ray spectrum are identified based on the energy content of the X-rays emitted by their electrons as these electrons transfer from a higher-energy shell to a lower-energy one.....	182
Figure A4-2: Cross-section for the $^{16}\text{O}(d,p_{0+1})^{17}\text{O}$, reaction.....	184
Figure A4-3: Stopping power and range for ^2H in NiCr alloy.....	184
Figure A5-1: Secondary electron image by FIB of single splats of NiCr on; a) aluminium substrate, b) copper substrate and c) mild steel substrate.	185

Figure A5-2: STEM image and elemental maps of the NiCr splat and Cu substrate interface..	186
Figure A5-3: Diffraction patterns from Figure 5-10 and their corresponding indices	187
Figure A6-1: ERDA spectra plus SIMNRA simulations of oxidised aluminium samples and a mylar film.....	191
Figure A6-2: NRA spectra from the oxidised substrates.	191
Figure A6-3: RBS spectra and overlaid simulations of the oxidised substrates.	192
Figure A6-4: A plot of aluminium depth profiles extracted from RBS spectra using RUMP software.....	192
Figure A6-5: Bright field image and elemental maps of a splat-substrate interface region for a NiCr splat HVAF thermally sprayed on an oxidised aluminium substrate.	193
Figure A6-6: 3D reconstructed image: View 1. This view of the whole splat includes the oxide and substrate.....	195
Figure A6-6: 3D reconstructed image: View 2. This view of just the underside of the NiCr splat shows the turbulent interface.....	195
Figure A6-6: 3D reconstructed image: View 3. This view is the same view underneath the NiCr splat as View 3 but includes interfacial voids.....	196
Figure A6-6: 3D reconstructed images: View 4. This view is of the NiCr splat and aluminium oxide underside.....	196
Figure A6-6: 3D reconstructed image: View 5. Same as View 4 but with Al oxide rendered semi-transparent. This view is of the NiCr splat, aluminium oxide underside plus voids..	197
Figure A6-6: 3D reconstructed image: View 6. This is a top view of the aluminium oxide layer and aluminium substrate.....	197
Figure A6-6: 3D reconstructed image: View 7. This view is the same as view 6 but showing the voids as well. Similar to view 5, this view shows that the voids do not occur at location where the oxide has fractured.	198
Figure A6-6: 3D reconstructed image: View 8. This view is a cross-section view of the NiCr splat, voids, aluminium oxide and aluminium substrate shows how contact between splat and substrate occurs.....	198
Figure A6-7: 3D reconstructed images: Overview.	199
Figure A7-1: Secondary electron image of a HVOF coating on an aluminium substrate showing a range of indents and splat morphologies.	201
Figure A7-2: Images of typical splat morphologies on the HVOF thermally sprayed substrate. a) solid splat; b) semi-molten splats; c) larger molten splat with substrate deformation; d) smaller molten splats with minimal substrate deformation and e) indent with smooth surfaces	202
Figure A7-3: Secondary electron images of HVAF NiCr coatings on aluminium substrates: a) Unheated; b) 340 °C and c) 500 °C.	204
Figure A7-4: Images of typical splat morphologies on the HVAF thermally sprayed aluminium substrate at room temperature: a) solid splat; b) semi-molten splats; c) indent with smooth surfaces.....	205
Figure A7-5: Secondary electron images of typical splat morphologies on the HVAF thermally sprayed aluminium substrate preheated to 340 °C; a) solid splat; b) semi-	

molten splat;c) molten splat – large; d) molten splat – small; and d) indent with smooth surfaces	206
Figure A7-6: Secondary electron images of typical splat morphologies on the HVOF thermally sprayed aluminium substrate preheated to 500 °C: a) solid splat; b) semi-molten splat; c) molten splat – large; d) molten splat – small; and d) indent with smooth surfaces.	207
Figure A7-7: SEM images and elemental maps of a splash splat on aluminium preheated to 500 °C. These images confirm that the bright features beside the impact craters are solidified “splashes” of molten NiCr splats.	208
Figure A7-8: SEM images and elemental maps of a splash splat on aluminium preheated to 500 °C. These images confirm that the bright features beside the impact craters are solidified “splashes” of molten NiCr splats.	209
Figure A7-9: Ratio of splat types on aluminium substrates, highlighting the effect of additional heat applied by the HVOF technique or by preheating the aluminium substrate.	211
Figure A7-10: Molten splat HVOF coated onto an aluminium substrate imaged by secondary electrons (top left image). This splat was sectioned by FIB milling and imaged in a TEM. The bright field picture (top right image) and elemental maps are shown.....	214
Figure A7-11: Bright field image and elemental maps measured at the interface. The location of this scan is indicated in Figure A7-10.	215
Figure A7-12: Bright field image and elemental maps of an interface region. The location of this scan is indicated in Figure A7-10.....	216
Figure A7-13: A TEM bright field picture and elemental maps of an interface region of the particle shown in Figure A7-10.	217
Figure A7-14: An X-ray spectrum of the interfacial oxide in Figure A7-13.....	218
Figure A7-15: Elemental line scan across the interfacial oxide shown in Figure A7-13.	218
Figure A7-16: Bright field image showing the location of two line scans.	219
Figure A7-17: Line scans across the interface region show non uniform interfacial oxidation and non uniform diffusion..	219
Figure A7-18: Aluminium oxide diffusion into the NiCr splat at the substrate-splat interface.	221
Figure A7-19: A NiCr splash splat on an aluminium substrate preheated to 500 °C..	222
Figure A7-20: Bright field image (BF) and elemental maps of an interface region of the splat in Figure A7-19.....	223
Figure A7-21: Line scans across the interface region as indicated in Figure A7-20.....	224

List of Tables

Table 2-1: Thermal spray coating applications.	3
Table 2-2: Comparison of Cold Spray and Thermal Spray Processes.	7
Table 2-3: Physical states of splats typically observed for various thermal spray methods.	17
Table 3-1. Summary of thermal spray experiments in this thesis.	30
Table 3-2: Summary of HVAF thermal spray conditions	31
Table 3-3: Substrates studied in “Effect of substrate”	32
Table 3-4: Substrates studied in “Interfacial bonding of solid NiCr splats”	32
Table 3-5: Substrates studied in “Effect of particle/substrate heating”	33
Table 3-6: Substrates in “Influence of oxide layers on splat bonding”	33
Table 3-7: Ion Beam Analysis (IBA) techniques used in this thesis.	51
Table 3-8: NRA nuclear reactions for $E_d=0.920$, $\theta=150^\circ$.	55
Table 3-9. Oxide thicknesses of metal substrates used in this study determined using NRA.	55
Table 3-10: Resonance reactions, ion energies and gamma-ray energies used in this study.	57
Table 3-11: Stopping powers using to calculate the depth scale in the depth profiles.	57
Table 3-12: Composition of the raw NiCr 80:20 alloy powder (METCO 43VF-NS) from the product specification sheet supplied by Sulzer Metco.	61
Table 3-13: Composition of the two different types of particles found in both the raw powder and coatings.	63
Table 3-14: Surface composition of the NiCr particles and coatings.	66
Table 3-15a: X-ray photoelectron spectroscopy (XPS) binding energies for the Ni80/Cr20 powder and thermal spray coating.	71
Table 3-15b: X-ray photoelectron spectroscopy (XPS) binding energies and concentrations, for the Ni80/Cr20 powder and thermal spray coating.	72
Table 4-1: Substrate materials HVAF thermally sprayed.	74
Table 4-2: Summary of NiCr splat types on various substrates	78
Table 4-3: Survey results of splat morphology types on various substrates.	79
Table 4-4: Calculation of the dimensionless parameter of heat diffusion distance/particle diameter $=x^2/D_{th}t$ and $X_D =$ thermal diffusion distance.	88
Table 4-5: Latent heat of fusion	90
Table 4-6: Relationship between splat thermal energy and temperature.	90
Table 4-7: Percentage of solid and molten splats for varying amounts of kinetic energy transferred into heat energy. $T_p=1,274$ °C, Std dev =14%, Particle velocity = 670 ms^{-1} and 975 ms^{-1}	93
Table 5-1: Theoretical and measured d-spacings for the diffraction patterns in Figure 5-8.	108
Table 6-1: Summary of the oxide compositions and thicknesses determined by IBA and SEM	116
Table 6-2. Summary of spat type percentages for various aluminium substrates	126
Table 6-3: Splat dimensions and oxide thicknesses for two sectioned splats.	128

Table A1-1: Grinding and polishing procedure for metallographic sample preparation	158
Table A4-1: List of principle X-ray energies for Z=1..38.	183
Table A4-2: NRA nuclear reactions for $E_d=0.920$, $\theta=150^\circ$.	184
Table A6-1: Oxide layer thickness measurements from SEM images in Figure 7-1.	188
Table A6-2: IBA experimental conditions.	188
Table A6-3: The elemental profile derived for the hydrothermally grown oxide.	190
Table A6-4: The elemental profile derived for the electrochemically grown oxide.	190
Table A6-5: Summary of the oxide compositions and thicknesses determined by IBA and SEM	190
Table A7-1a: Survey results of NiCr splat morphology types on aluminium substrates.	210
Table A7-1b: Survey results of splat morphology types on various substrates.	210
Table A7-2: Features determined from the two line scans shown in Figure A7-21	225