CHARACTERISATION OF ALUMINIUM AND ITS ALLOYS AFTER SURFACE PRE-TREATMENT PRIOR TO ELECTRODEPOSITION

ROBERT WILLIAMS-OYENIGBA

and

C.F. ODUOZA

OUTLINE OF PRESENTATION

- Introduction
- The zinc immersion process
- Aims and objectives
- Methodology
- Results
- Conclusion

Introduction

Problem Definition - Aluminium , a versatile engineering material , reacts readily in the presence of oxygen to form an oxide film which makes it difficult to plate .

Types of surface pre-treatment are:

1. Mechanical Preparation (Dennis and Such, 1993).
2. Chemical Etching (Work,1933 (in Wernick et.al.,1987)).
3. Stannate immersion process (Bryan ,1953 (in Wernick et.al.,1987)).
4. Anodic oxidation (Arrowsmith and Clifford, 1986).
5. Zinc immersion process (Wernick, et.al.,1987).

The Zinc Immersion Process

This is a surface pre-treatment method whereby a zincate solution is used to deposit zinc on the surface of aluminium and its alloys to improve its quantitative adhesion.

The basic net reactions of the Zinc immersion process are:

1. The dissolution of aluminium oxide :

$$Al_2O_3 + 2NaOH + 3H_2O \qquad 2NaAl(OH)_4$$

2. The deposition of zinc:

$$3Na_2Zn(OH)_4 + 2Al_{(substrate)} \qquad 2NaAl(OH)_4 + 4NaOH + 3Zn_{(deposited)}$$

Types of the zinc immersion process:

- The single zinc immersion process (Hewitson, 1927 (in Wernick et.al.,1987)).
- The double zinc immersion process (Korpuin, 1939 (in Wernick et.al., 1987)).

Aim and Objectives

Aim -To study and compare the surface characterisation of three types of aluminium alloys after a double zinc immersion process.

Objectives :

- To study the kinetics of the double zincating process by weight characterisation.
- To determine how variations in the immersion times of the zincating process affects the surface characteristics.
- To study and compare the double zinc immersion process for three different types of aluminium alloy.
- To verify the effect of the double zinc immersion process on the adhesive properties of aluminium/aluminium alloys prior to electrodeposition.

Methodology

A laboratory-scale experiment carried out on samples of three types of aluminium alloys . The stages of the experiment are :

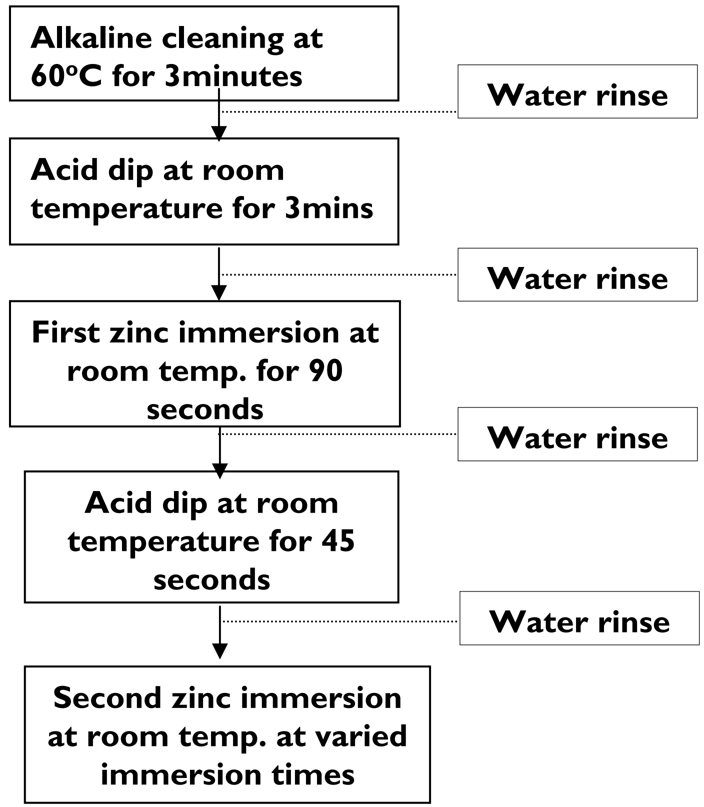


Fig1: The stages of the experiment

Methodology (continued)

Resources

The aluminium samples and their compositions are given in the table below:

Material Designation	Main Alloying Element Composition									
	Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Al	
Al 1050	0.25	0.40	0.03	0.05	0.05	-	-	0.07	99.50	
Al 6061	0.4-0.8	0.70	0.15-0.4	0.15	0.8-1.2	0.04-0.35	-	0.2-0.25	Rem	
Al 6082	0.7-1.3	0.50	0.10	0.4-1.0	0.6-1.2	0.25	-	0.20	Rem	

Other resources used are:

- Minco cleaner – An alkaline compound (MacDermid plc).
- 66 – Microetch – An acidic compound (MacDermid plc).
- Bondal dip – A Modified Alloy Zincate solution (MacDermid plc).

Methodology (continued)

Surface Analytical Techniques

The surface analytic techniques used are listed below:

- Scanning Electron Microscopy (A Zeiss EVO 60 series Scanning Electron Microscope).
- Energy Dispersive X-Ray Analysis (A Zeiss EVO 60 series Scanning Electron Microscope).
- X-Ray Diffraction (A Phillips PW 1730 X-Ray Diffractometer).
- X-Ray Fluorescence Spectroscopy (A Spectro Xepos Spectrometer).

Results

The weight characterisation

Weight characterisation of Al 1050

First Experiment	**Before zincating (g)**	**After zincating (g)**
Immersion time of 25 seconds	2.06	2.051
Immersion time of 30 seconds	2.14	2.093
Immersion time of 35 seconds	2.10	2.0399
Second experiment		
Immersion time of 25 seconds	1.955	1.89
Immersion time of 30 seconds	2.074	2.008
Immersion time of 35 seconds	2.0133	2.002

Weight Characterisation of Al 6061

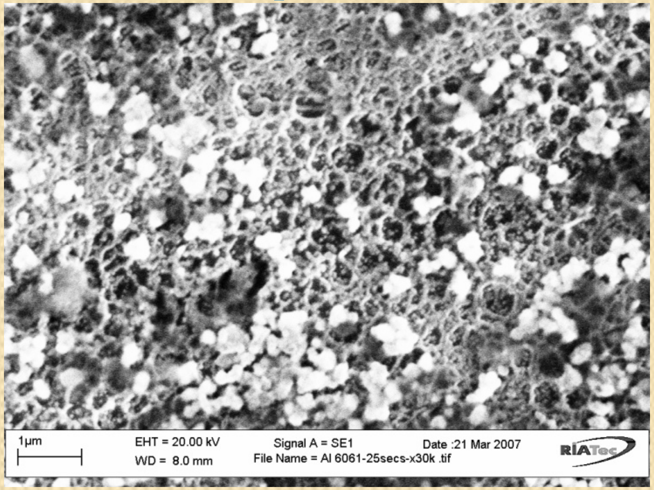
First experiment	**Before zincating (g)**	**After zincating (g)**
Immersion time of 25 seconds	2.3018	2.2655
Immersion time of 30 seconds	2.4166	2.4288
Immersion time of 35 seconds	2.89	2.9075
Second experiment		
Immersion time of 25 seconds	2.5872	2.4205
Immersion time of 30 seconds	2.3925	2.2804
Immersion time of 35 seconds	2.2895	2.297

Results (continued)

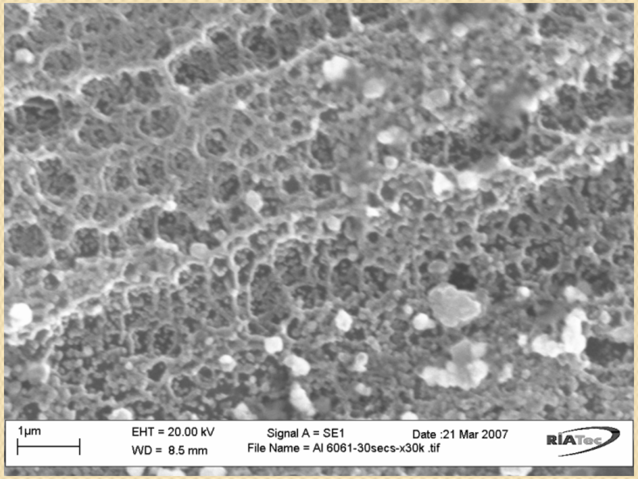
Weight characterisation of Al 6082

First Experiment	Before zincating (g)	After zincating (g)
Immersion time of 25 seconds	1.9326	1.9302
Immersion time of 30 seconds	1.9623	2.0254
Immersion time of 35 seconds	2.0209	2.0074
Second experiment		
Immersion time of 25 seconds	2.0181	1.9825
Immersion time of 30 seconds	1.9018	1.8417
Immersion time of 35 seconds	2.0701	2.0843

SEM Analysis of Al 6061



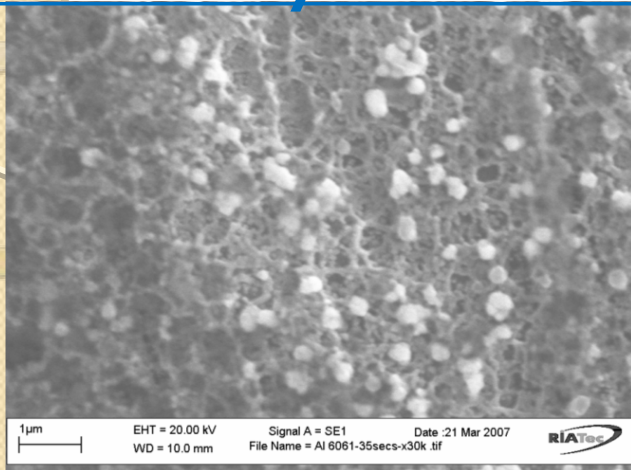
Second immersion time of 25 seconds



Second immersion time of 30 seconds

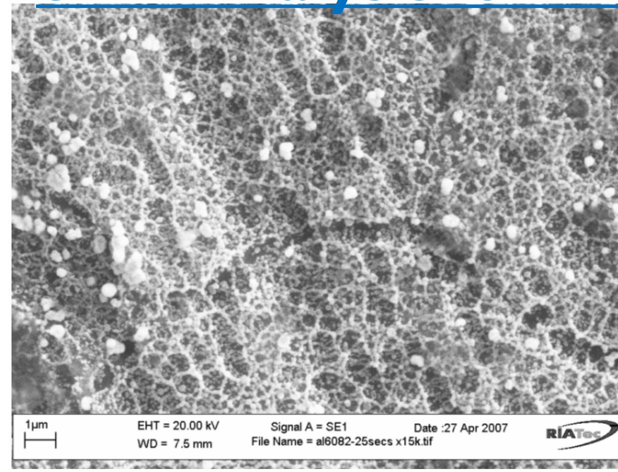
Results (continued)

SEM Analysis of Al 6061



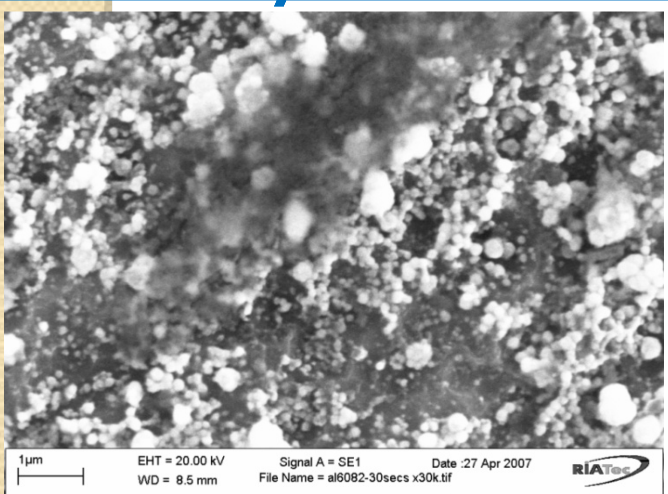
Second immersion time of 35 seconds

SEM Analysis of Al 6082



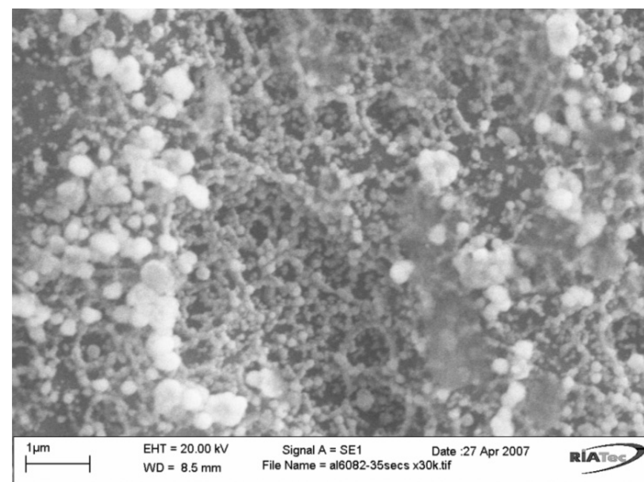
Second immersion time of 25 seconds

SEM Analysis of Al 6082



Second immersion time of 30 seconds

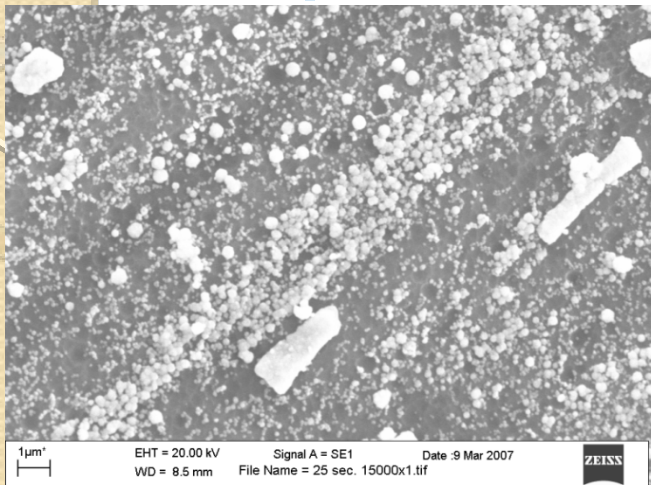
SEM Analysis of Al 6082



Second immersion time of 35 seconds

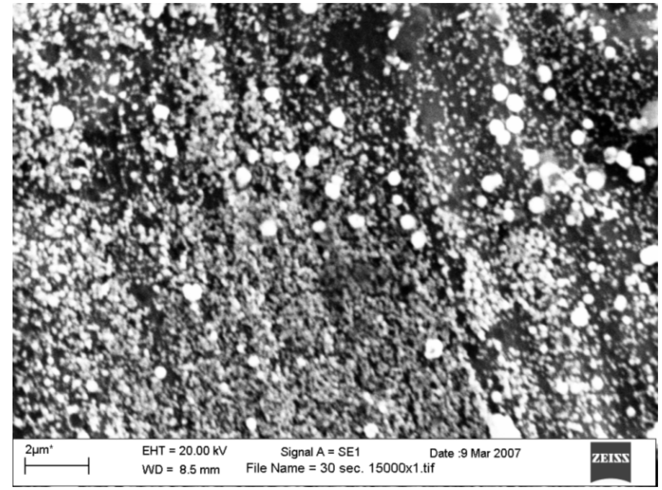
Results (continued)

SEM Analysis of Al 1050



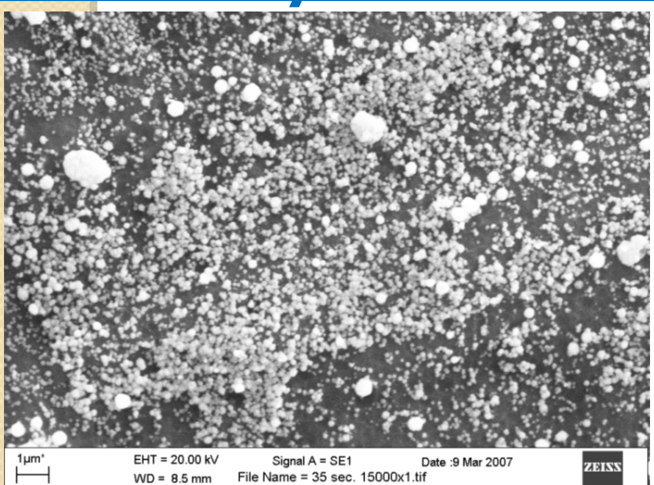
Second immersion time of 25 seconds

SEM Analysis of Al 1050



Second immersion time of 30 seconds

SEM Analysis of Al 1050



Second immersion time of 35 seconds

Results (continued)

XRF Spectroscopy of the aluminium samples

Al 1050

Immersion times	Aluminium %	Zinc %	Iron %	Copper %	Nickel %
25-sec	97.06	0.09288	0.181	0.02625	0.01089
30-sec	95.07	0.1473	0.1881	0.03826	0.01705
35-sec	95.94	0.1676	0.1891	0.04244	0.01878

Al 6061

Immersion times	Aluminium %	Zinc %	Iron %	Copper %	Nickel %
25 seconds	96.07	0.1087	0.1643	0.03483	0.01549
30 seconds	96.13	0.1296	0.18	0.03405	0.1296
35 seconds	95.74	0.1375	0.1803	0.03839	0.01826

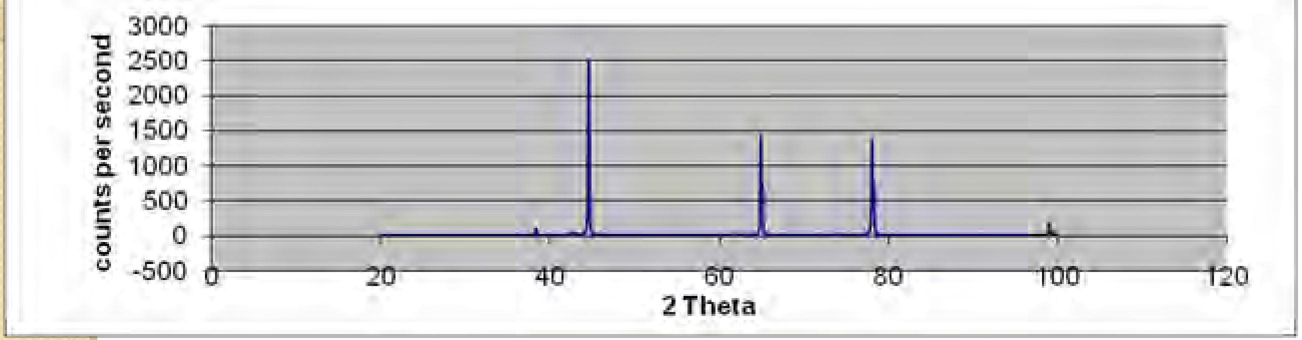
Al 6082

Immersion times	Aluminium %	Zinc %	Iron %	Copper %	Nickel %
25 seconds	92.86	0.1445	0.4123	0.0916	0.0916
30 seconds	91.59	0.198	0.4423	0.1067	0.02706
35 seconds	91.06	0.2016	0.4462	0.1071	0.02636

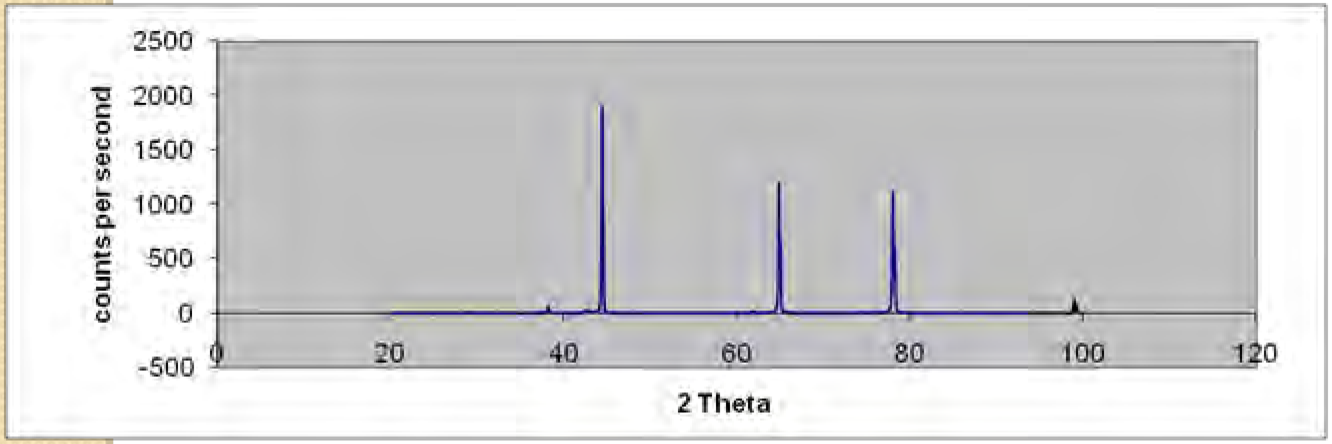
Results (continued)

XRD analysis of the aluminium samples

A diffraction profile for Al 1050 at 25 seconds

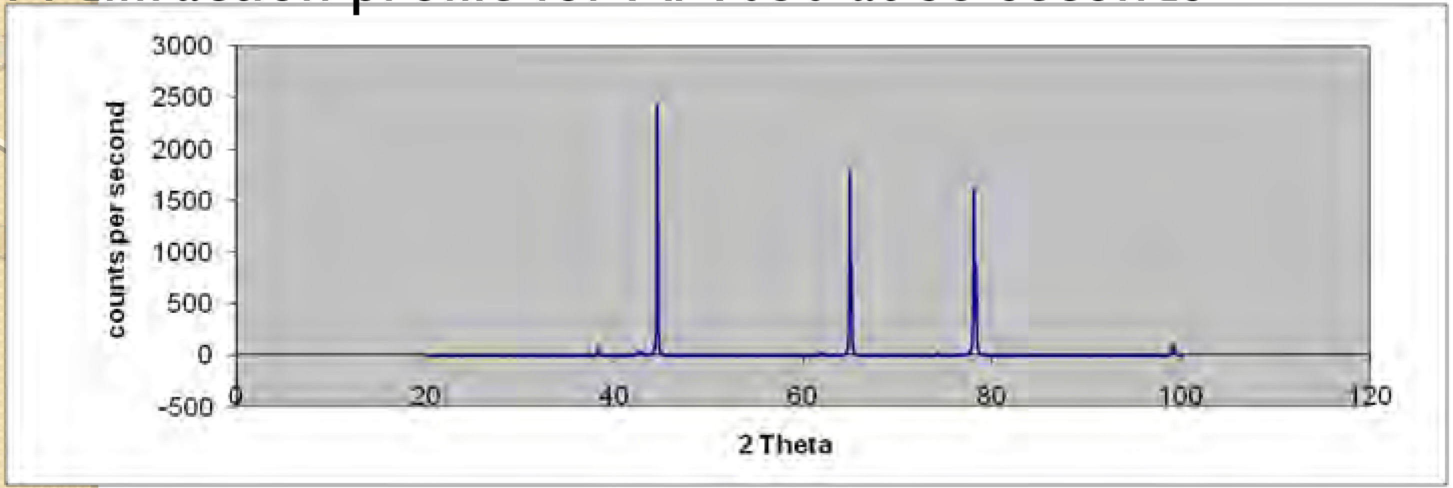


A diffraction profile for Al 1050 at 30 seconds

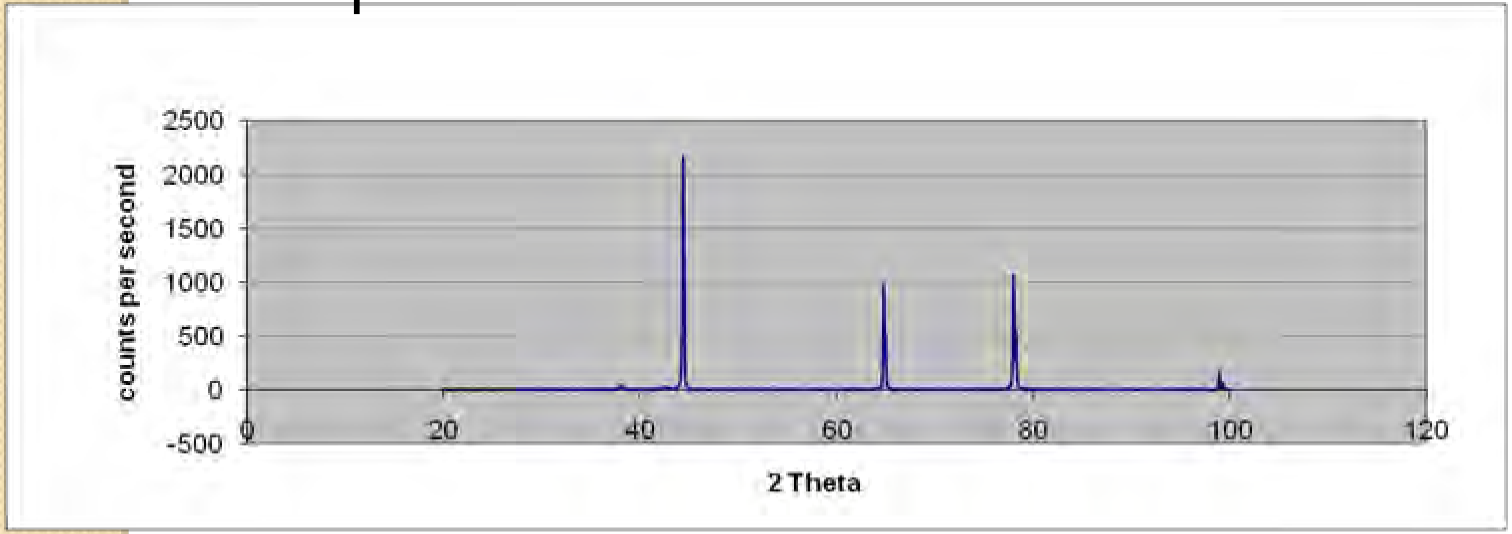


Results (continued)

A diffraction profile for Al 1050 at 35 seconds

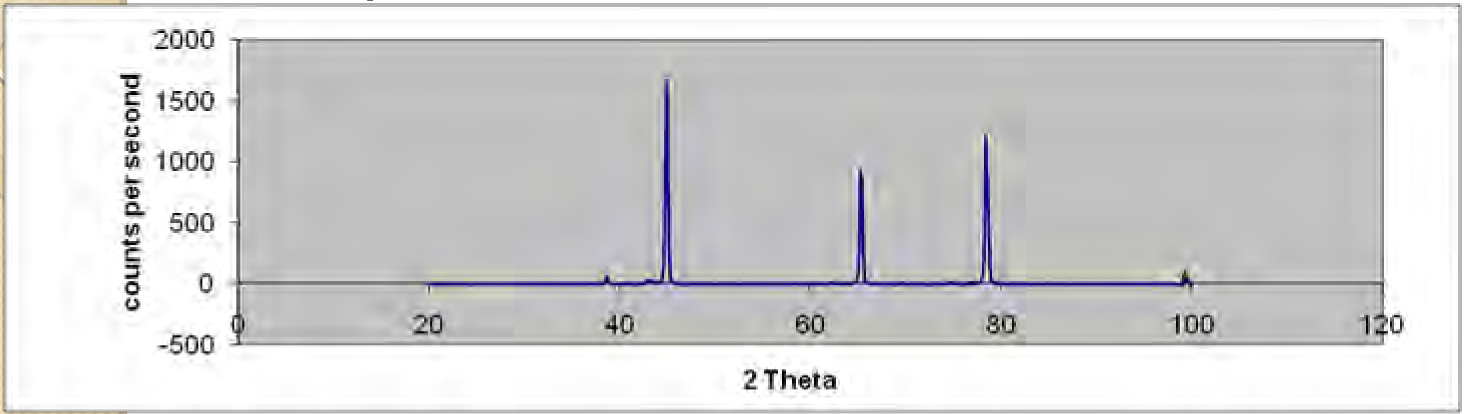


A diffraction profile for Al 6061 at 25 seconds

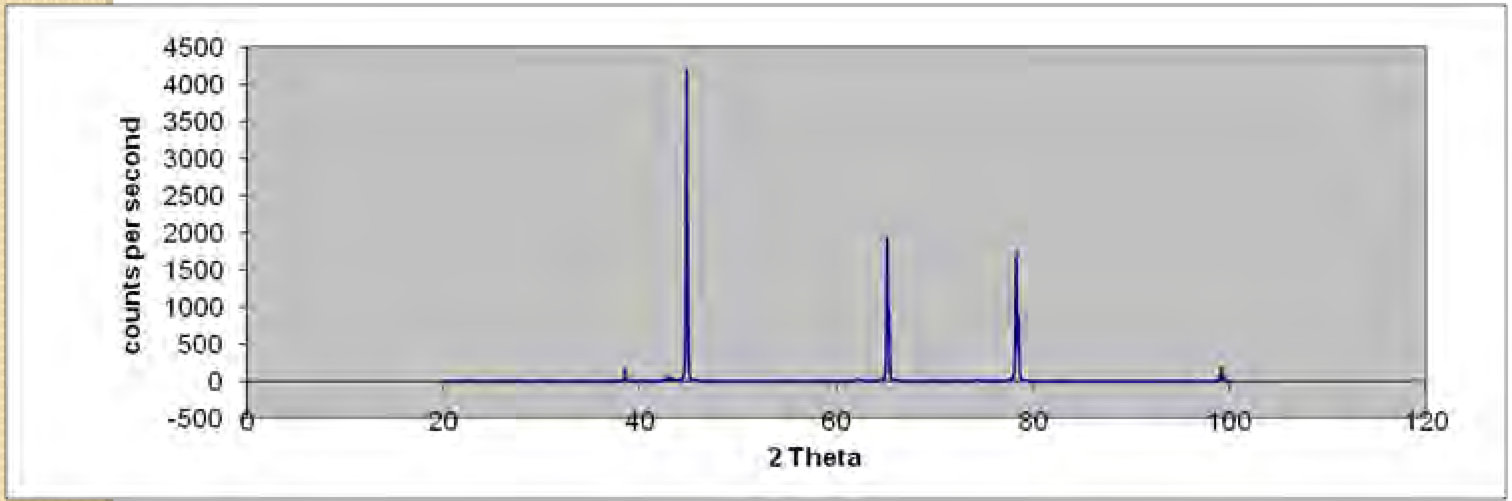


Results (continued)

A diffraction profile for Al 6061 at 30 seconds

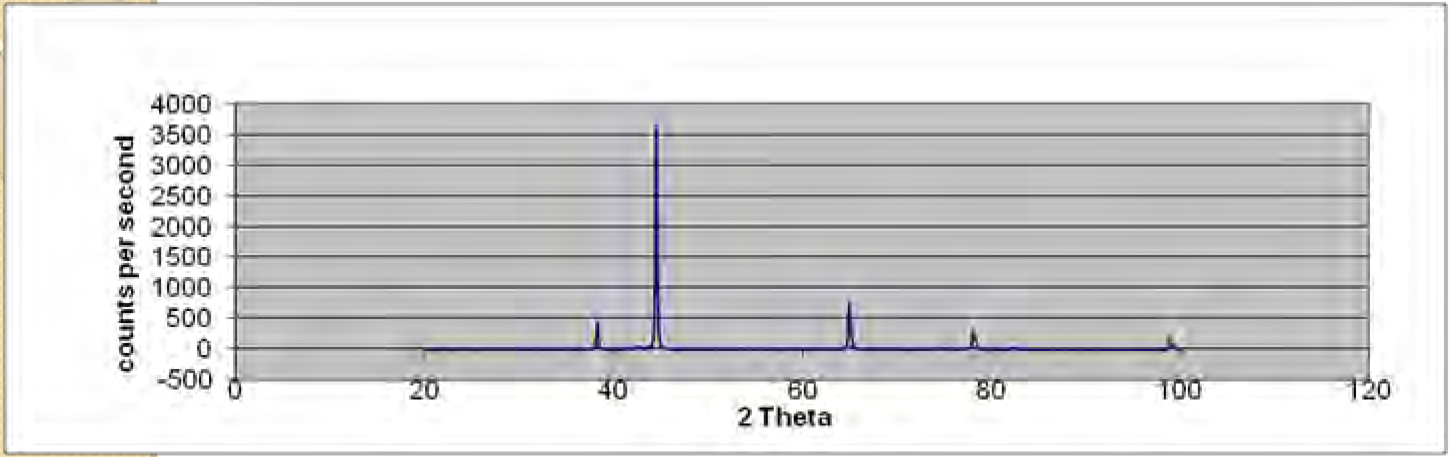


A diffraction profile for Al 6061 at 35 seconds

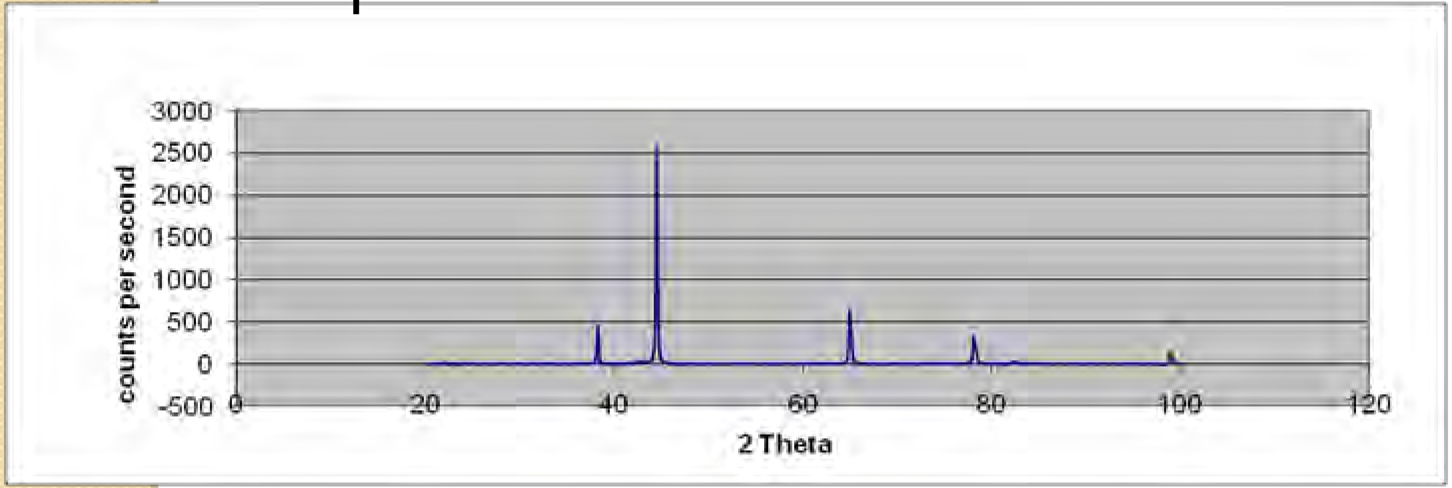


Results (continued)

A diffraction profile for Al 6082 at 25 seconds

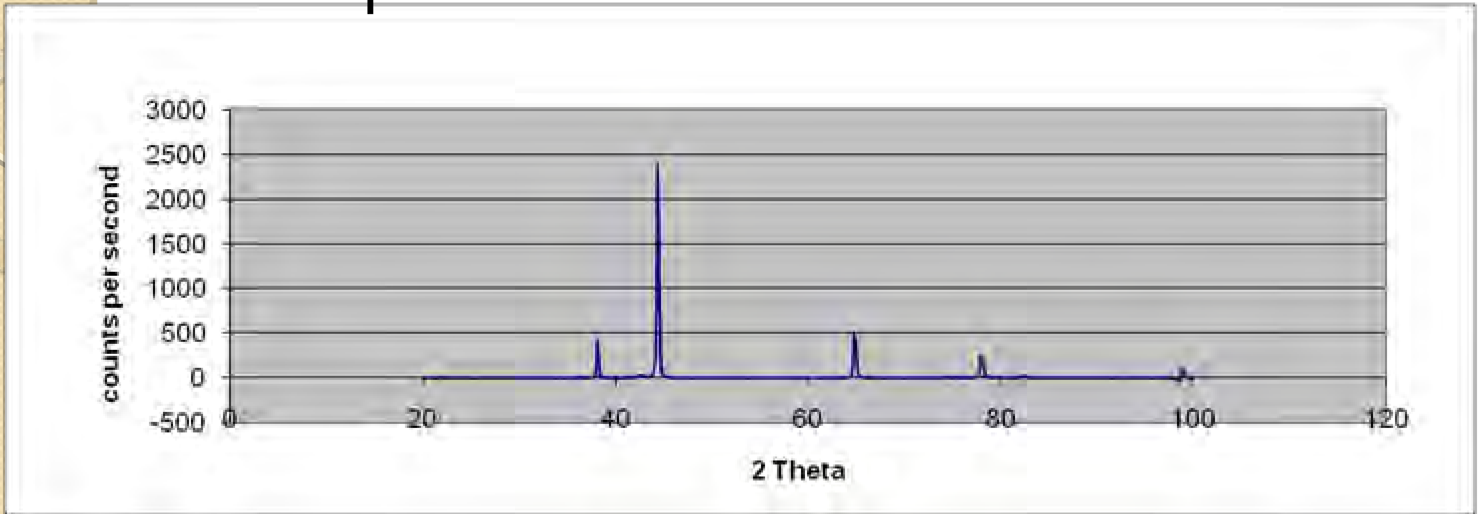


A diffraction profile for Al 6082 at 30 seconds



Results (continued)

A diffraction profile for Al 6082 at 35 seconds



Calculation of grain size

The Scherrer method was used to calculate the grain size of the samples. The equation is given below:

$$D_{vol} = \frac{K\lambda}{FWHM * \cos\theta}$$

Conclusion

- Al 1050 exhibits better quantitative adhesion property than Al 6061 and Al 6082.
- The zinc deposit on Al 1050 is thinner and more compact than Al 6061 and Al 6082.
- For optimum adhesion property, the sequence and parameters of the double zinc immersion process is dependent on the composition of the aluminium alloying elements such as Magnesium (Mg) etc.
- The immersion times has a profound effect on the degree of adhesion.