Kovine, zlitine, tehnologije / letnik 29 / 1995 / št. 5–6 / strani 545–547

Surface Oxide Analysis of Water Atomised Al and Al-Si Powders

Analiza oksidne plasti vodnoatomiziranih prahov Al in Al-Si

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A water atomisation technique has been used to produce rapidly solidified Al and Al-Si powders. The thickness of the oxide layer was determined by Auger electron spectroscopy (AES). The type of the oxide was determined by x-ray diffraction.

Key words: water atomisation, Al-Si powders, oxide layers

Po postopku vodne atomizacije smo izdelali prahove vrste Al in Al-Si. Debelino oksidne plasti na delcih smo ocenili z Augerjevo elektronsko spektroskopijo. Tip oksidne plasti smo določili z rentgensko difrakcijsko analizo.

Ključne besede: vodna atomizacija, Al-Si prahovi, oksidne plasti

1. Introduction

The surface bound oxygen on atomised powder is a very important factor in the processing of high performance PM materials. The surface condition of the powder will have a significant impact on the amount and distribution of oxygen in the final compact and its mechanical properties. In this work results are presented on the investigation on the oxide layers in the base metal and the alloys AlSi6, AlSi12 and AlSi19[1,2,3,4].

2. Experimental procedure

The morphology and surface topography of particles were investigated in Scanning Electron Microscope. Depth profiles of the oxide layers were obtained by successive A_r^+ ion etching and Auger analysis. The measured velocity of etching on the standard Cr_2O_3 sample was about 6nm/min. All examinations were performed under the same condition. The oxide layer was identified by x-ray diffraction.

3. Results

Powders of aluminium and AlSi6, AlSi12 and AlSi19 alloys in two size ranges (0,09-0,125 mm and <0,045 mm) were investigated. The purpose was to establish the influence of the size range and the content of silicon on the thickness of the surface oxide layer. The morphology of AlSi19 particles are presented on **Fig 1a** and **Fig 2a**, while in **Fig 1b** and **Fig 2b** an example of their AES analysis is shown.

Evaluations of the oxide layer thickness for the size range 0,09-0,125 mm are given in **table 1** and for the size range <0,045 mm in **table 2**. Because of the particles morphology the topographic effect, during the ion etching, deteriorated the resolution of the analysis and a more clear distinction between the oxide layer and the metal. A better resolution could be achieved only on planar surface. The evaluation of the AES analysis shows, that the particles in the size range 0,09-0,125 mm have almost the same average layer thickness (415nm) as the particles in the size range <0,045 mm (410nm).

Table 1: Oxide thicknesses for particles of size range 0,09–0,125 mm
Tabela 1: Debelina oksidnih plasti za velikostni razred delcev 0,09–0,125 mm

Sample	ion etching time(min)	oxide thickness(nm)
Al	65	390
AlSi6	73,5	440
AlSi12	71,5	430
AlSi19	67	400

Table 2: Oxide thicknesses for particles of size range <0,045mm
Tabela 2: Debelina oksidnih plasti za velikostni razred delcev <0,045mm

Sample	ion etching time(min)	oxide thickness(nm)
Al	75	450
AlSi6	67	400
AlSi12	61,5	370
AlSi19	70	420

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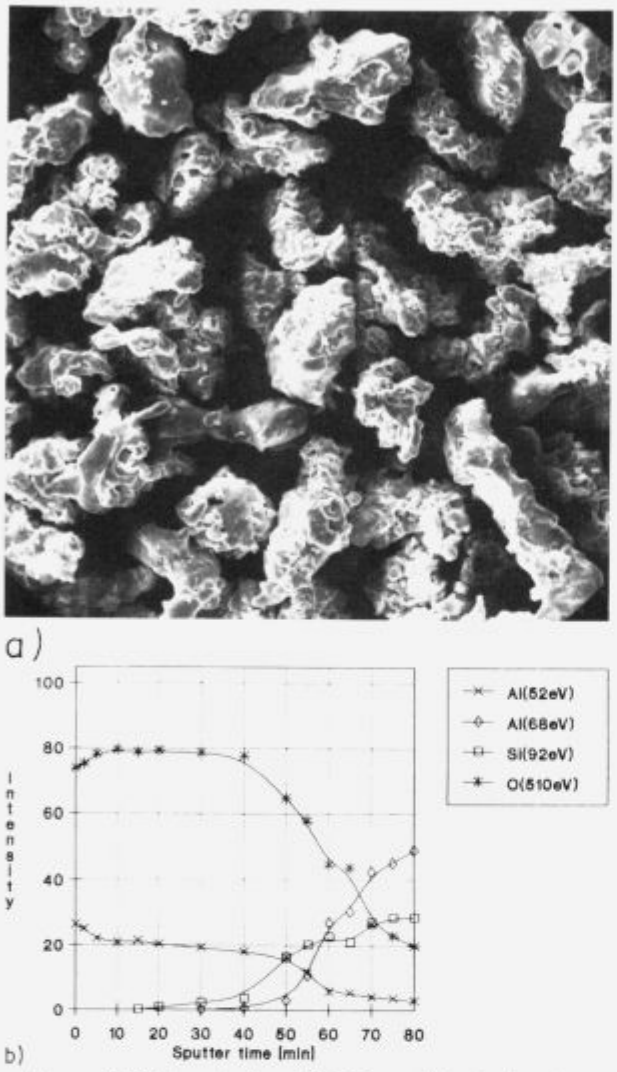

Figure 1: Water atomised AlSi19 particles in the size range 0,09-0,125 mm: **a)** SEM morphology image, **b)** AES depth profile of the oxide layer

Slika 1: Vodnoatomizirani delci AlSi19 v velikostnem razredu 0,09-0,125 mm: **a)** SEM posnetek oblike delcev, **b)** AES globinski profil oksidne plasti

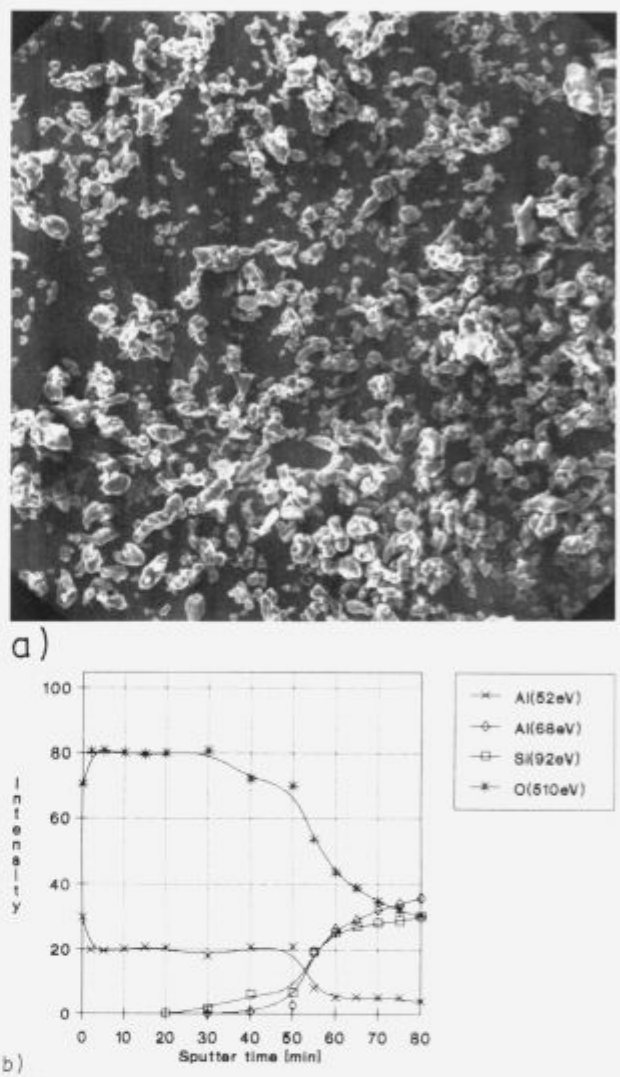

Figure 2: Water atomised AlSi19 particles in the size range <0,045 mm: **a)** SEM morphology image, **b)** AES depth profile of the oxide layer

Slika 2: Vodnoatomizirani delci AlSi19 v velikostnem razredu <0,045 mm: **a)** SEM posnetek oblike delcev, **b)** AES globinski profil oksidne plasti

XRD spectra shown in **Figure 3** were obtained for the oxide layer on 0,09-0,125 mm and on 0,045 mm powder size. High intensity peaks indicates Al and Si presence in the sample. Inspite of the low intensity due to the small volume of analysed oxide, a few peaks (B_1-B_4) were clearly recognized and the oxide present on the surface of the particles was identified as boehmite, aluminum oxide hydroxide (gamma-AlOOH).

Table 3: Measured parameters for B_1-B_4
Tabela 3: Izmerjeni parametri za B_1-B_4

Peak	2-theta(deg)	(h,k,l)
B_1	14,458	(0,2,0)
B_2	28,181	(1,2,0)
B_3	38,337	(0,3,1)
B_4	48,930	(0,5,1)

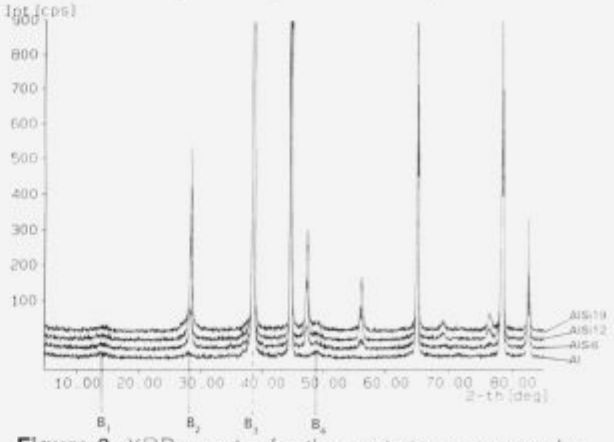

Figure 3: XRD spectra for the oxide layer on powder particles

Slika 3: Rentgenski difrakcijski spektri oksida na površini delcev prahu

4. Conclusions

The surfaces of the water atomised Al, AlSi6, AlSi12 and AlSi19 powders in two different size ranges were examined. It is concluded that:

- the oxide thickness, determined by AES depth analysis, is not significantly influenced by the Si content in Al matrix or by the size range of the particles. The determined average thickness of the oxide is approximately 0,4μm.
- The oxide in the layer on PM particles is boehmite (gamma-AlOOH).

5. References

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