



SECTIONS AND VENUES OF THE CONFERENCE

Sign	Name	Venue	
Plenary	Plenary session	Lecture hall XXXVII.	Between Bld. A/3-A/4. 1 st floor
A	Environmental and Energy Management	Lecture hall VI.	Bld. A/1. 1 st floor, 101.
B	Earth Science and Engineering	Lecture hall VIII.	Bld. A/1. 1 st floor, 115.
C-D	Applied Materials Science and Technologies	Káldor Mihály Room	Bld. B/1. groundfloor
E	Mathematics and Computer Science	Room 341.	Bld. A/4. 3 rd floor, 341.
F	Physics and Physics Education	Room 13.	Bld. A/1. mezzanine 13.
		Room 112.	Bld. B/1. groundfloor

D: APPLIED MATERIALS SCIENCE AND TECHNOLOGIES

VENUE: Káldor Mihály Room, Bld. B/1. groundfloor

Chairman: Péter BARKÓCZY *assoc. professor*

Secretary: Zsolt DUGÁR *PhD Student*

Date: March 22, 2013

- 9.00 Corneliu Gligor Univeristy of Oradea, Romania
Continuous Improvement Processes as a Tool for Performance/process Performance Turnaround in Metallurgical Industry
- 9.20 Christoph Pichler, Gerald Schneeberg, Jürgen Antrekowitsch University of Leoben, Austria
Utilization of Residues from the Iron and Steel Industry with Main Focus on Filter Dusts
- 9.40 Gerald Schneeberger, Christoph Pichler, Jürgen Antrekowitsch University of Leoben, Austria
Investigations in the Behaviour of Quasi-Ternary Slag Systems during Recycling of Residues from Steel Industry
- 10.00 Mónika Tokár, György Fegyverneki, Jenő Dül, Valéria Mertinger University of Miskolc, Hungary
Desingning and Testing the Casting die With Variable Wall Thickness for Studying of the Al-Si Foundry Alloys
- 10.20 Gergely Bálint Tóth, Zoltán Harangi, Tibor Kulcsár, Tamás Kékesi University of Miskolc, Hungary
Metal Content of Drosses Arising from the Melting of Aluminium Alloy Scrap

METAL CONTENT OF DROSSES ARISING FROM THE MELTING OF ALUMINIUM ALLOY SCRAP

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ABSTRACT

Drosses obtained from industrial furnaces melting magnesium or manganese alloyed and unalloyed aluminium scrap were treated at 900 °C temperature for 1 hour applying mechanical forces and different salt additives with or without the use of argon protective atmosphere. The highest total metal recovery (approx. 88%) referring to the mass of the sample could be achieved from the drosses obtained from the melting of unalloyed aluminium scrap. The drosses obtained from the melting of manganese alloyed aluminium scrap yielded approximately 75% metal and those from magnesium alloyed charges offered a metal recovery slightly higher than this value if Ar atmosphere was used and slightly lower without it. Most of the metal was obtained as directly cast ingots or coarse particles after grinding the granulated slag residue. The fraction of metal content in the fine sub millimetre particles generally amounted to just a few per cent, only significant in the case of magnesium alloyed materials. The simple NaCl salt additive was found more efficient than the conventional MgCl₂ based covering salt or the fluoride containing furnace cleaning salt. Treating the dross with the fluoride containing salt without Ar protective atmosphere reduces the metal recovery significantly.

1. INTRODUCTION

Efficient melting of aluminium and its alloys is not an easy metallurgical task because of its specific physical and chemical properties. The heating of the material is relatively difficult, as specific heat capacity [1] of solid aluminium is high:

$$C_{Al,s}=0.93+0.00021t, \quad J/g^{\circ}C \quad (1)$$

where C – is the specific heat capacity and t is the technical temperature. At further stages, the also high heat of fusion (~ 400 J/g) hinders melting. During the whole process of heating and melting, oxide formation causes metal losses [2]. Thus beyond maintaining productivity, it is also difficult to determine the precise amount of scrap to be charged into the melting furnace for obtaining the required mass to be tapped. Properly controlling the conditions of melting may facilitate the economically desired higher ratios of scrap used in producing aluminium melts for the continuous casting of ingots. Therefore, it is important to examine the processes leading to excessive dross formation in cases of melting different aluminium alloys. Treating the collected dross material with mechanical agitation at high temperature to relieve the entrapped metal and analysing the composition of the residual oxide fraction may reveal the conditions leading to excessive dross formation.

Experience has shown [3] that higher ratios of magnesium containing alloys and loose scrap characterised by high specific surface areas result in higher degree of dross formation during aluminium melting. Furthermore, superficial contamination of the scrap can strongly increase the amount of generated dross. The dense amorphous oxide layer formed at relatively

low temperatures on the clean surface of aluminium is only several nanometres thick, which may increase to a few micrometres until the melting point is reached. However, keeping the scrap in humid atmosphere develops an additional porous oxide coating of a few micrometres - containing some water - above the primary dense oxide layer. The melt is further oxidised, however as the effective surface is reduced, this only results in a thin skin layer protecting the melt from direct contact with the atmosphere. The rate of further oxidation mainly depends on the exposure of the molten metal to oxygen and overheating.

Solubility of the oxide in molten aluminium is less than 5 ppm [1], and although the inherent density of the formed $\gamma\text{-Al}_2\text{O}_3$ (3.8 g/cm^3) is higher than that of the molten aluminium alloy ($2.3 - 2.4 \text{ g/cm}^3$), it may float because of the high surface tension and the small article size. The oxide particles can stabilize the thin layers of melt entrapped and due to the high specific surface of $\gamma\text{-Al}_2\text{O}_3$, gases are usually also adsorbed. Overheating not just increases the rate of oxidation reaction, but it causes the $\gamma\text{-Al}_2\text{O}_3$ to transform into a denser $\alpha\text{-Al}_2\text{O}_3$ phase, thereby breaking the protective oxide skin. The broken chain of the solid particles entrapping a relatively large ratio of molten metal forms the dross at the surface of the melt. It consists of larger lumps of porous material if the aluminium is alloyed with especially magnesium and manganese. It suggests that the possible formation of complex oxide phases (eg. MgAlO_4) changes the properties of the dross to facilitate further oxidation. Figure 1 indicates that magnesium is the most reactive component in aluminium alloys and it readily forms spinel compounds, thus melting of Al-Mg alloys may be the most affected by dross formation and consequent metal losses.

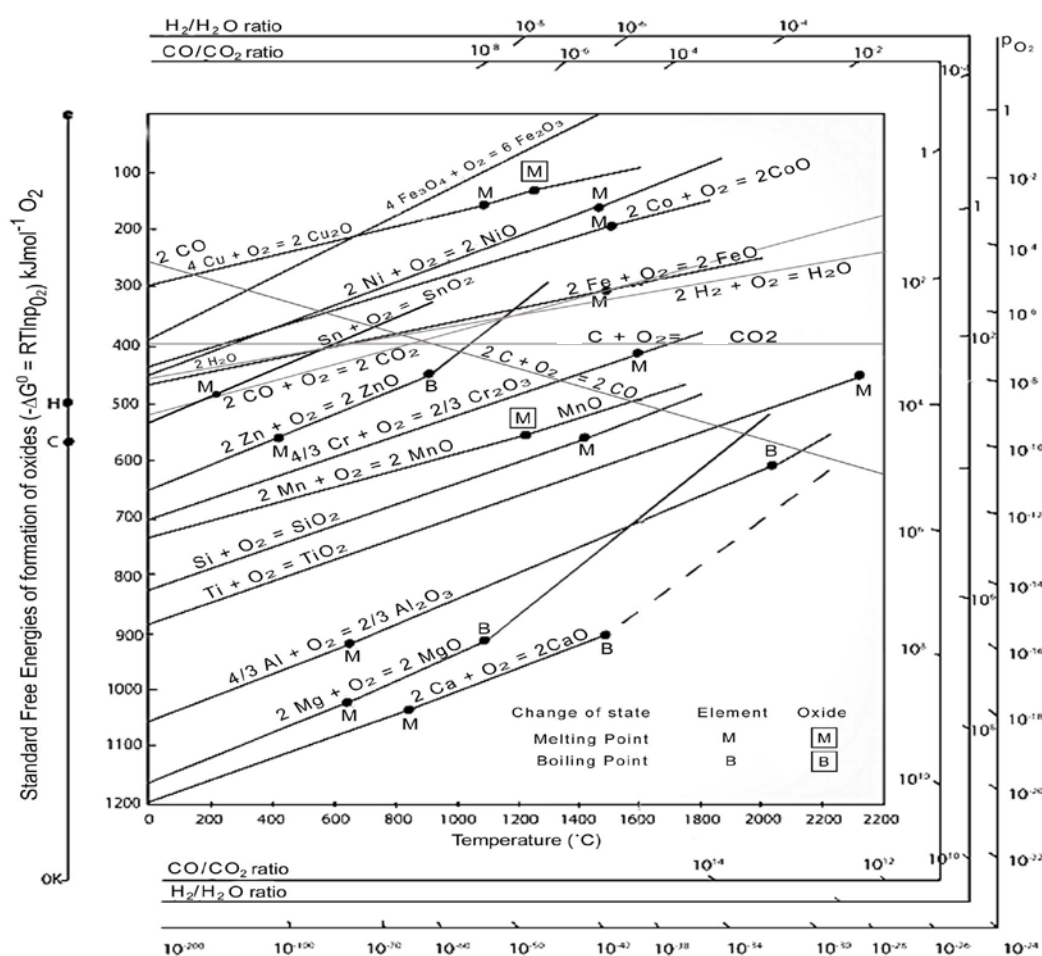


Fig. 1 The thermodynamic characteristics of oxidation [4]

As it can be derived from the relevant standard Gibbs free energy function in Fig.1, the oxidation of aluminium generates much heat (~ 1100 kJ/mol O_2). The exothermic effect tends to result in superficial overheating, which in turn further accelerates the reactions leading to excessive oxide formation. According to the thermodynamic conditions shown in Fig 1, aluminium can also be oxidised by the water vapour and carbon dioxide content in the furnace gases at elevated temperatures:



The standard Gibbs free energy function referring to the oxidation of aluminium practically corresponds to the equilibrium partial pressure of oxygen in this reaction. It is seen in Fig. 1 that even if the H_2/H_2O partial pressure ratio is increased to 10^{20} , the water vapour can still oxidise aluminium at the temperatures of melting. Similarly, even at a partial pressure ratio for CO/CO_2 of 10^{10} carbon dioxide could oxidise molten aluminium.

The thin layers of molten aluminium spread over the porous oxide agglomerates, thereby getting extensively exposed to oxidation. Thus the physical form of the dross may be a decisive factor in governing the processes causing metal loss. This effect may become crucial if not only Al_2O_3 is formed but the also present complex oxide phases produce larger agglomerated lumps. In this case the word of expertise “*dross makes more dross*” may be justified. Thin layers of the metal can easily be isolated from each other by the surface oxide layer, which is continually increasing during heating. The surface coating makes it impossible for the thin layers of molten metal to unite. If oxidation proceeds fast, it may happen that thin aluminium scrap (like foils) cannot yield any melt, only oxide is formed out of them. In this case, mechanically breaking the barrier layers will help producing a liquid pool.

The oxide layer at the surface of the molten aluminium droplets prevents coalescence during the melting procedure. Application of salts may help producing a liquid pool of molten aluminium. This mechanism [5,6] is illustrated in Fig. 2.

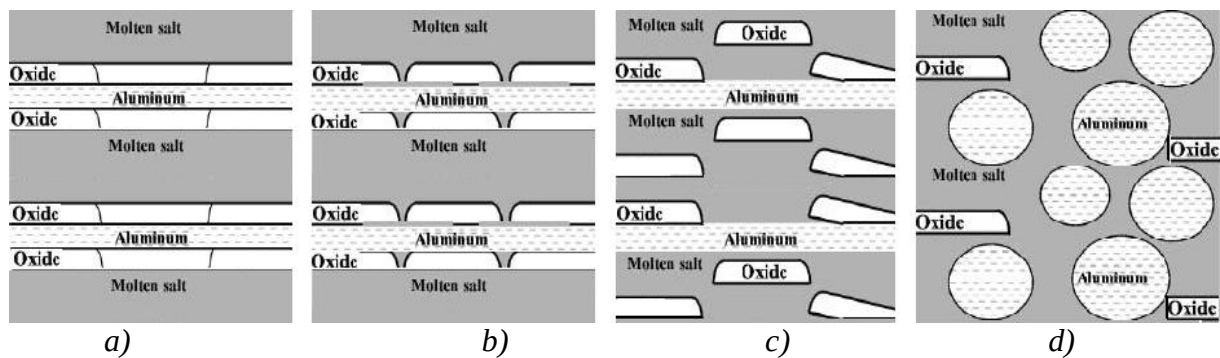


Fig. 2 The effect of the molten salt on the oxide layer on molten aluminium (a – dense oxide coatings separating thin Al layers, b – breaking up of the oxide layer and intrusion of the salt, c – dispersion of the broken oxide, d – free aluminium droplets, ready to coalesce)

The main criteria for the added salts include low values of liquidus temperature, viscosity, surface tension and vapour pressure, as well as high chemical stability, ability to take up non-metallic impurities and not reacting with the furnace lining materials [1]. Therefore, the alkali and alkaline earth metal chlorides are used as the main components and more or less aluminium fluoride or cryolite (Na_3AlF_6) or other fluorides can also be added. The lowest dynamic viscosities ($1 \sim 1.5$ mPas) and the lowest surface tensions ($80 - 100$ mN/m) at the

melting temperatures are offered by KCl and NaCl. These properties and the high chemical stability make these substances the staple salt components used for melting aluminium, however MgCl_2 is also common. The surface tensions of molten salts are almost an order of magnitude lower than those of molten metals. In facilitating the coalescence of metal droplets, the main effects of the molten salts arise from their preferential wetting of aluminium. This is a result of the lower interfacial surface tension [7] between the molten aluminium and the salt than the surface tension of aluminium. This interfacial surface tension is further reduced if fluorides are added to the basically chloride salt mixture [8,9], as shown in Fig.3.

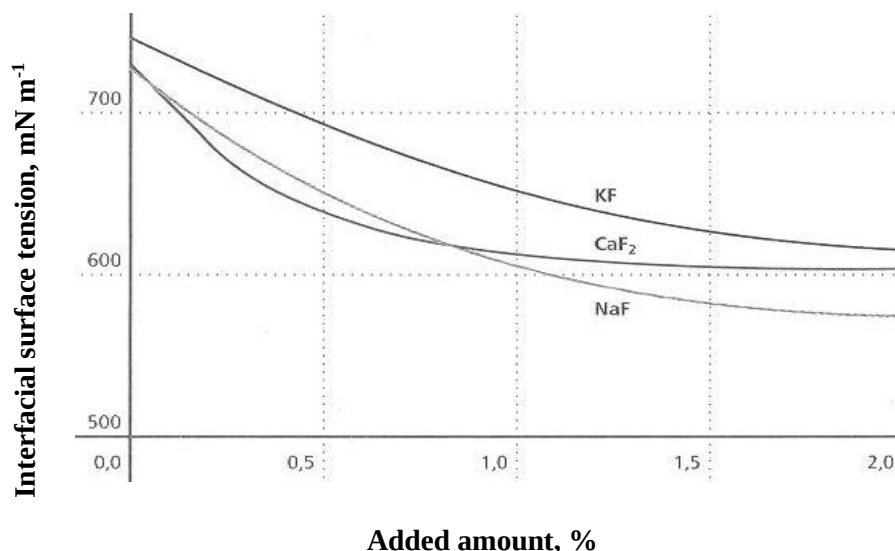


Fig.3 The effect of fluoride addition on the interfacial surface tension between the equi-molar NaCl-KCl salt mixture and aluminium at 800 °C [1]

On the other hand, alloying elements –especially magnesium - in molten aluminium can also modify the wetting properties. Figure 4 shows how the inherently high surface tension of pure aluminium is reduced by alloying. It also implies that the effect of salt addition can be weaker in cases of melting highly alloyed aluminium scrap.

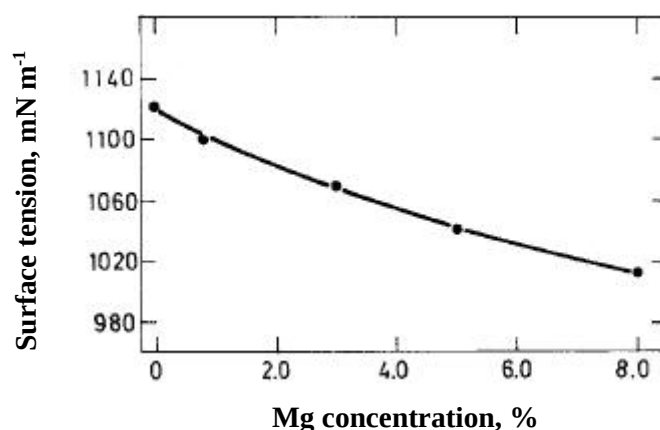


Fig. 4 The effect of Mg concentration on the surface tension of the molten aluminium alloy at the temperature of melting [1]

Aluminium can be separated from the covering oxide layer if the molten salt can penetrate between the two phases. Penetration is possible through the cracks of the oxide layer arising from external mechanical effects and the transformation of $\gamma\text{-Al}_2\text{O}_3$ into the α -structure at

higher temperatures, or chemical erosion of the oxide layer. This latter effect is also attributed to the fluoride components in the applied salt mixture.

Drosses formed at the surface of the melted pool can trap metal not only because of the oxide coating of the droplets, but also because some molten metal adheres to the surface of the spongy agglomerate formed of the solid oxide particles. This fraction of entrapped metal – usually the overwhelming portion of the metallic constituent in the dross - can be extracted directly by heating and applying mechanical agitation at the same time. This is the industrial practice usually applied at the sites of larger melting facilities. In order to examine the samples collected from the drosses discharged during the melting of different aluminium alloys in industrial reverberatory furnaces, we have adopted this type of hot mechanical treatment followed by the selective grinding of the granulated slag residue. Such a complex treatment may reveal the nature and the distribution of the entrapped metal of drosses produced by the melting of the main types of wrought aluminium alloys.

2. EXPERIMENTAL PROCEDURE

Samples of the drosses obtained from the melting high magnesium containing (Al – high Mg), unalloyed (Al) and manganese containing (Al- Mn) alloys were taken to represent approximately similar granulometric composition and 500 g mass in each case. Three different salts (50 g) were alternatively added to the upper region of the dross samples in a crucible furnace (HK.AL 4/10 SSR) of 5 kW nominal power. The material was heated to reach and keep 900 °C temperature within 1 h duration. Subsequently, mechanical pressure was applied by using special tools, shown in Fig. 5, and the collected pool of metal was cast into an iron mould and the residual slag was transferred into cold water. This procedure took approximately 5 ~ 6 minutes after the heating period. The granulated slag was dried at 150 °C.

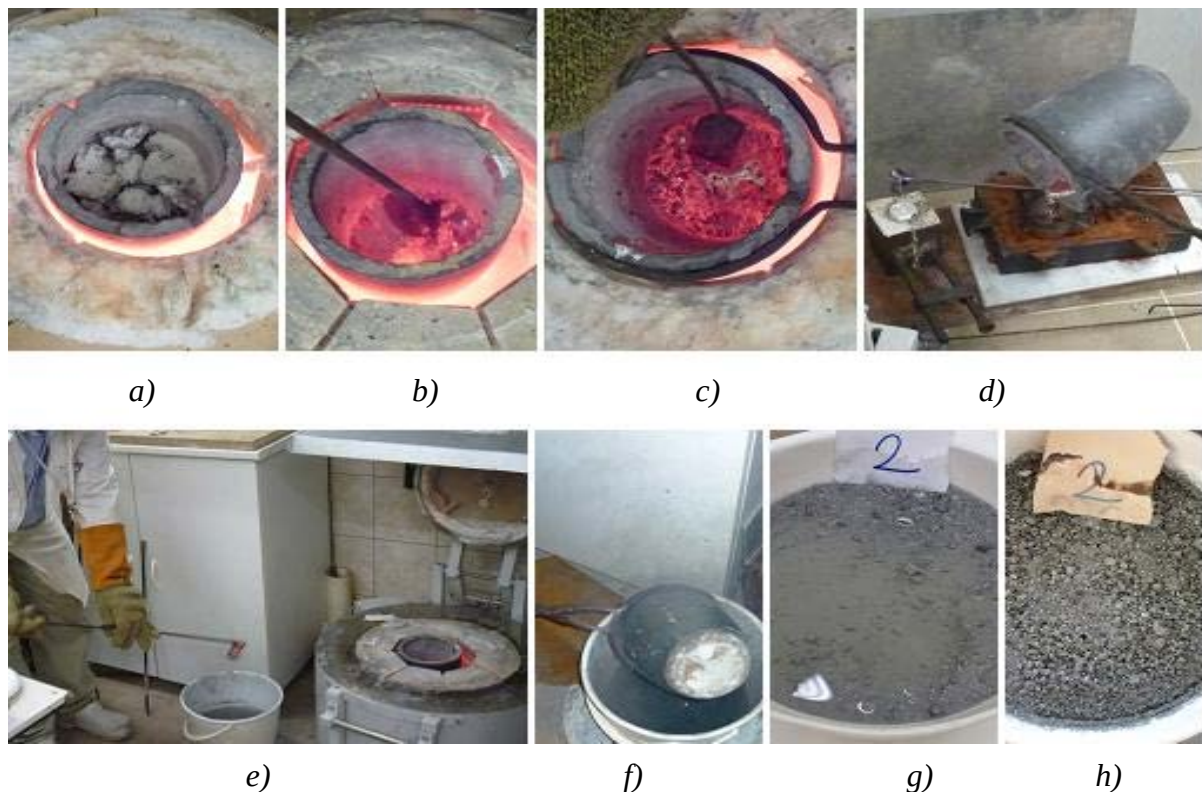


Fig. 5 Hot treatment of the dross samples (a – dross sample and salt, b, c – mechanical action, d – casting, e, f – granulation, g – wet residual slag, h – dry residual slag)

In order to extract also the fraction of the metal content which could not unite with the pool formed during the hot mechanical treatment, the granulated and dried residual slag was attrited and ground in a laboratory mortar grinder (RetschMühle KM-1), followed by removing the metal granules, and subsequently fine grinding and classifying with a sieve of 0.65 mm mesh size. The grinding and classification steps are illustrated in Fig. 6.

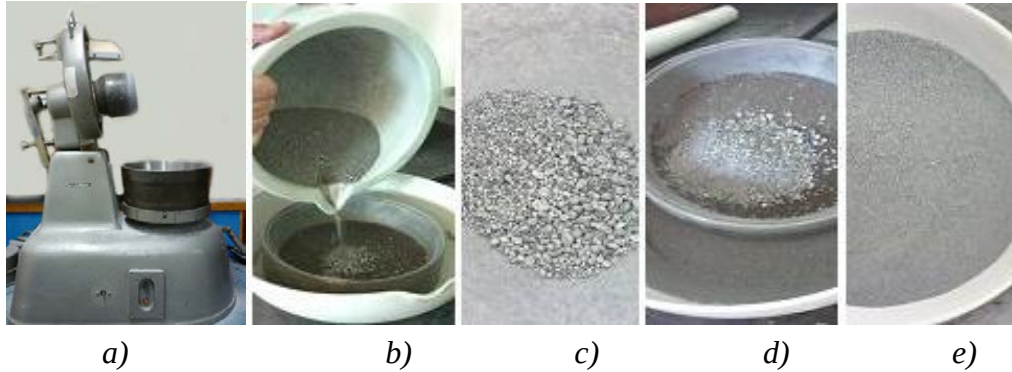


Fig. 6 Separation of metal granules and fine grinding followed by classification of the residue (*a* – gyratory attrition crushing, *b* – rough sieving, *c* – granules, *d* – fine grinding of the intermediate fraction, *e* – < 1 mm fine powder)

The masses of the fractions constituting the ingots, granules and the fine powder, shown in Fig. 7, were measured. Those of the ingots and the granules could be considered as metallic.

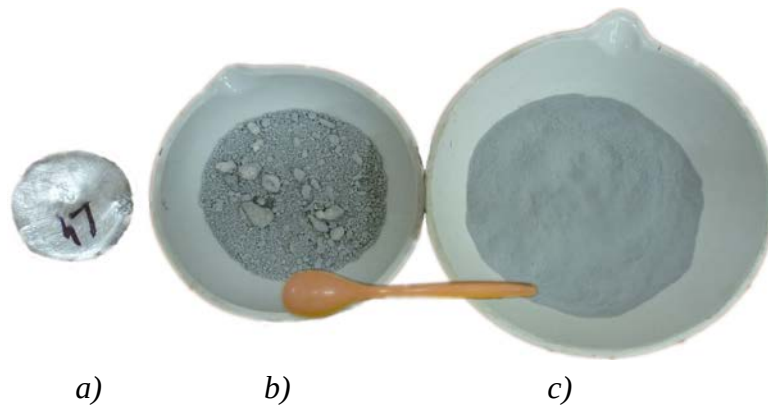
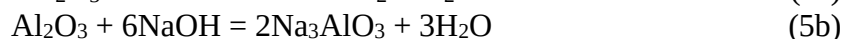
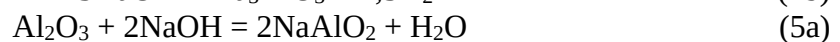
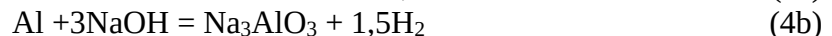
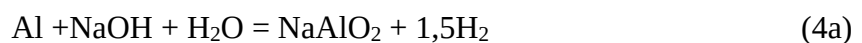


Fig. 7 The fractions obtained from the complex treatment of the dross samples (*a* – ingots, *b* – granules, *c* – fine powder).

The fine powder, however contains some metal with free surface or under the cover of persistent oxide coating. This metal content could be determined by measuring the volume of hydrogen evolved during the dissolution of a carefully weighed mass of the powder sample in 6M NaOH reagent at 60 °C, applying a Pt mesh as catalyst and a textile bag fixed in a copper spiral to maintain the powder sample centred in the reactor vessel, whereas aluminium oxide is dissolved generating only water, as shown by the relevant reaction equations:



The volume of the gas was measured and corrected for the hydrostatic pressure difference in the burette and the vapour pressure of the NaOH solution. Applying this gas volume corrected for atmospheric pressure and room temperature, the stoichiometric relationships in eq. (4a and b) yielded the metal content in the fine powder fraction. The total amount of metal extracted from the dross sample and the distribution among the various examined fractions could be used as an indicator for the characteristics of dross formation. This aspect could be further clarified by examining the fine powder fraction applying scanning electron microscopy (SEM) (Zeiss UltraEVO MA10) equipped with an energy dispersive X-ray microprobe (EDX) and also X-ray diffraction (XRD) (Bruker D8 Advance) to identify the dominant phases.

3. EXPERIMENTAL RESULTS AND DISCUSSION

The Al-high Mg type of dross samples were obtained from the surface of different raw melts containing 1.5 ~ 1.9 % Mg concentration produced by melting charges consisting of Al-Mg scrap and unalloyed aluminium raw materials. The Al-Mn type dross samples were obtained from a raw melt of ~0.6 % Mn concentration produced by melting Al-Mn scrap and unalloyed aluminium. The raw melt concentration was computed by deducting the amount of the alloying elements from the analytical result obtained from the raw melt after dross removal and primary alloying. The Al type dross was obtained from an unalloyed raw aluminium melt containing only 0.001 % Mn and 0.004% Mg. Some of the ingots obtained from the hot mechanical treatment of the dross samples were analysed by GD-OES spectrometry.

The masses of the charged materials and the products obtained by the hot mechanical treatment and the subsequent grinding and granulometric classification are given directly beside the first two columns of Table 1. The amounts of the metal extracted as ingots, granules or analysed in the fine residual powder, as well as the calculated recovery rates are seen in the right side of the table.

Table 1 Materials charged and products obtained in the hot mechanical treatment combined with subsequent grinding and classification

Type	Ar	Mass, g								Metal content, g				Recovery, %	
		Input				Obtained								Ingots+ large gra.	Total
		Dross	NaCl	Cover.salt	Clean.salt	Ingot	Large gra.	Fine pow.	Total	Ingot	Large gra.	Fine pow.	Total		
Al-highMg	Yes	500	0	50	0	293	65	148	506	293	65	24	382	71,6	76,3
Al-highMg	Yes	500	0	50	0	320	38	150	508	320	38	26	384	71,6	76,9
Al-highMg	Yes	500	0	50	0	318	37	153	508	318	37	35	390	70,9	77,9
Al-highMg	Yes	500	0	50	0	273	83	163	519	273	83	40	397	71,3	79,4
Al-highMg	Yes	500	0	50	0	237	110	179	526	237	110	35	382	69,5	76,4
Al-highMg	Yes	500	0	50	0	260	92	154	505	260	92	24	375	70,3	75,1
Al-highMg	Yes	500	0	0	50	270	79	183	532	270	79	19	368	69,8	73,6
Al-highMg	Yes	500	0	0	50	300	91	159	550	300	91	14	406	78,3	81,1
Al-highMg	Yes	500	0	0	50	315	62	161	538	315	62	7	384	75,5	76,8
Al-highMg	No	500	0	0	50	215	128	180	523	215	128	17	360	68,6	71,9
Al-highMg	No	500	0	0	50	210	125	289	624	210	125	7	342	67,1	68,5
Al-highMg	No	500	0	50	0	205	129	297	631	205	129	16	350	66,8	70,0
Al-highMg	No	500	0	50	0	240	129	176	545	240	129	28	397	73,8	79,5
Al-highMg	Yes	500	50	0	0	252	134	141	527	252	134	27	413	77,2	82,5
Al-highMg	Yes	500	50	0	0	176	188	148	512	176	188	35	399	72,8	79,8
Al	No	500	0	50	0	385	41	74	500	385	41	13	439	85,2	87,9
Al	No	500	0	50	0	410	29	53	492	410	29	6	445	87,8	89,0
Al	No	500	0	0	50	399	31	157	587	399	31	6	436	86,0	87,3
Al	No	500	0	0	50	369	52	146	567	369	52	0	421	84,3	84,3
Al	No	500	50	0	0	405	36	47	487	405	36	8	449	88,1	89,7
Al	No	500	50	0	0	418	31	57	505	418	31	5	454	89,7	90,8
Al-Mn	No	500	0	0	50	352	27	181	560	352	27	3	382	75,8	76,3
Al-Mn	No	500	0	0	50	194	179	281	654	194	179	13	386	74,6	77,2
Al-Mn	No	500	0	0	50	215	170	239	624	215	170	1	386	77,0	77,2
Al-Mn	No	500	0	0	50	169	207	283	659	169	207	1	377	75,2	75,5
Al-Mn	No	500	0	50	0	170	198	281	649	170	198	11	379	73,6	75,8
Al-Mn	No	500	0	50	0	249	109	281	638	249	109	12	369	71,5	73,8

The effect of Ar protective atmosphere used during the hot treatment can be seen by comparing the recoveries obtained with the covering and cleaning salt additives shown in Figs. 8a and b. The argon atmosphere increased the yield by a mere 3-5 % about the ~ 76 % average total metal recovery from the high-Mg dross samples. Probably, the vapour of the added salts could protect the metal content of the treated dross from further severe oxidation under the closed lid of the crucible furnace. Therefore, further experiments were carried out without the application of Ar.

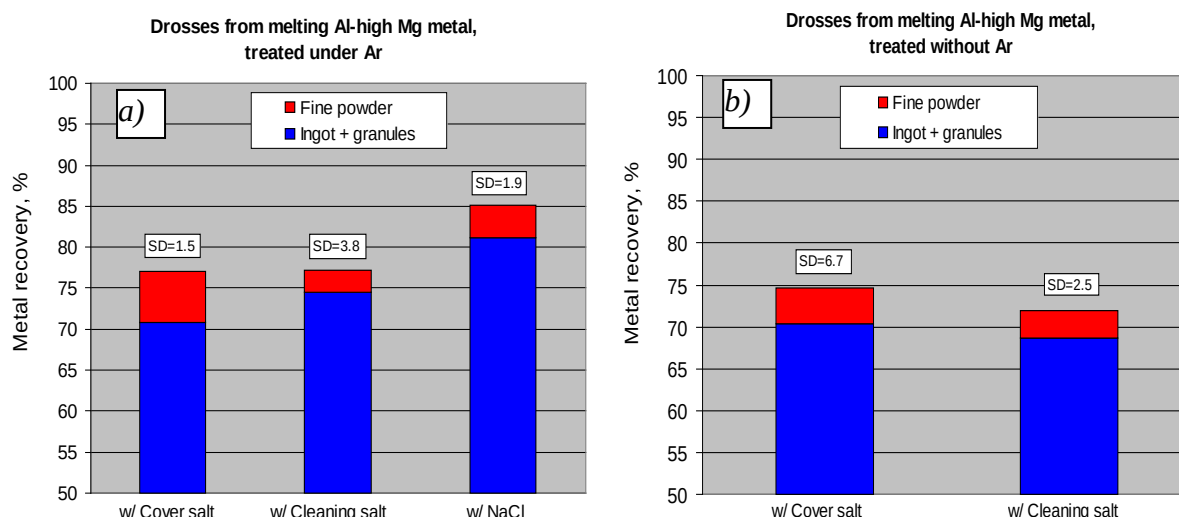


Figure 8 Partial and total recoveries from Al – high Mg type drosses treated under Ar (a) or without the application of protective atmosphere (b), applying different salt additions

Approximately the same amount of metal (~ 75%) could be recovered from the dross samples originating from the melting of charges containing Al-Mn scrap, as indicated in Fig. 9a. The highest amount of metal (~ 87%) was found in the dross samples obtained from the melting of unalloyed aluminium, as shown in Fig. 9b. Although relatively little dross is generated during the melting of such materials, it is scraped from the surface of the melt with a high metal content, which is efficiently recovered by the hot mechanical treatment, mostly in the form of large ingots. The fine powder collected after grinding contains little metal in this case.

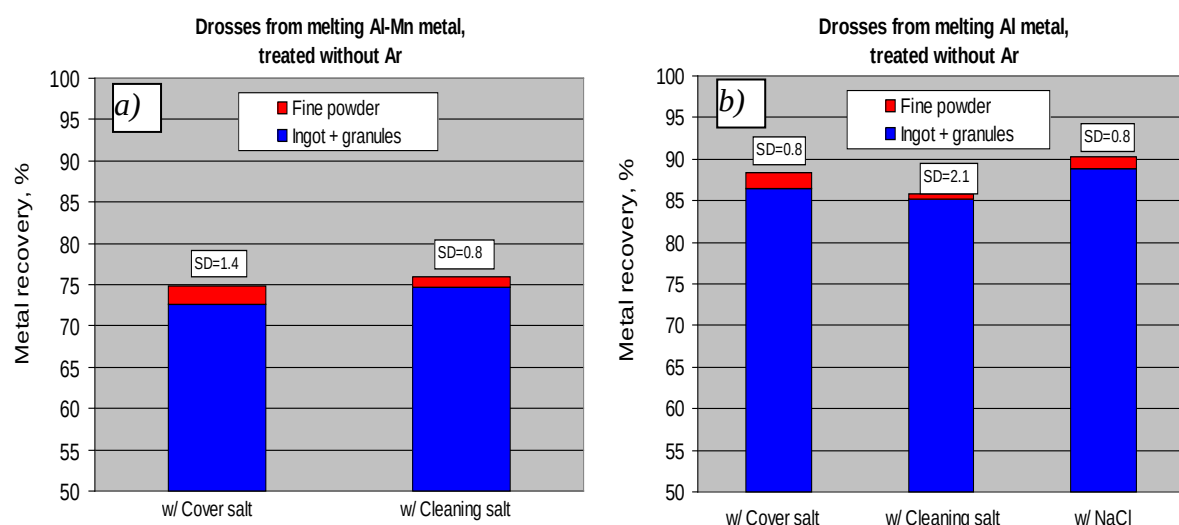


Figure 9 Partial and total recoveries from Al-Mn (a) and Al (b) type drosses treated without the application of protective atmosphere applying different salt additions

The virtually inert MgCl_2 -KCl cover salt used generally in the melting processes and the fluoride containing (Na_2SiF_6 - KCl-NaCl - Na_2SO_4) cleaning salt usually applied for removing accretions from the furnace lining, could produce similar efficiencies in extracting the metal content from all kinds of drosses. It may be surprising that the inexpensive NaCl salt added to the upper section of the dross sample in the crucible gave the best recovery results in the examined cases. This may be caused by the higher melting point keeping the salt closer to the top of the charge and due to the lowest boiling point, it can produce the most protective salt vapour cover. It is also remarkable that the cleaning salt reduced the metal recovery from the Al-high Mg type drosses. This result justifies the mechanism of the fluoride component liberating the surface of the metal, which has the highest effect in the case of the smallest droplets. As shown in Fig. 8b, in absence of an efficient isolation from the atmosphere, oxidation may convert more of these small metal particles unrecoverable. As a corresponding further indication, the metal content of the fine powder residue is also reduced.

The magnesium concentration in the metal extracted from the Al-high Mg type dross was generally reduced to $\sim 0,6\%$, if the sample was treated under Ar and to $0.3\sim 0.4\%$ when no protective atmosphere was applied. The manganese concentration was virtually unchanged. Application of the cleaning salt caused a marked increase in the Na concentration of the recovered metal ingots. Whereas it was ~ 2 ppm in the case of applying the normal cover salt in the case of Al-high Mg drosses, it reached ~ 10 ppm if the cleaning salt was added. In the case of drosses from unalloyed Al charges, the Na concentration in the recovered ingots was normally ~ 0.7 ppm but with the cleaning salt it increased above 3 ppm. This can be attributed to the reaction of Mg and also Al in the melt with the Na_2SiF_6 and Na_2SO_4 components at the elevated temperature of the hot mechanical treatment.

The effect of magnesium in the alloy on the generation of dross can be explained by the formation of the wrinkled surfaces characterising the MgAl_2O_4 oxidation product. The penetration of molten metal into the spongy structure of such drosses and the higher exposed surface of the melt causes increased rates of oxidation. The different physical forms of the relevant oxides are shown in the electron micrographs of Fig. 10.

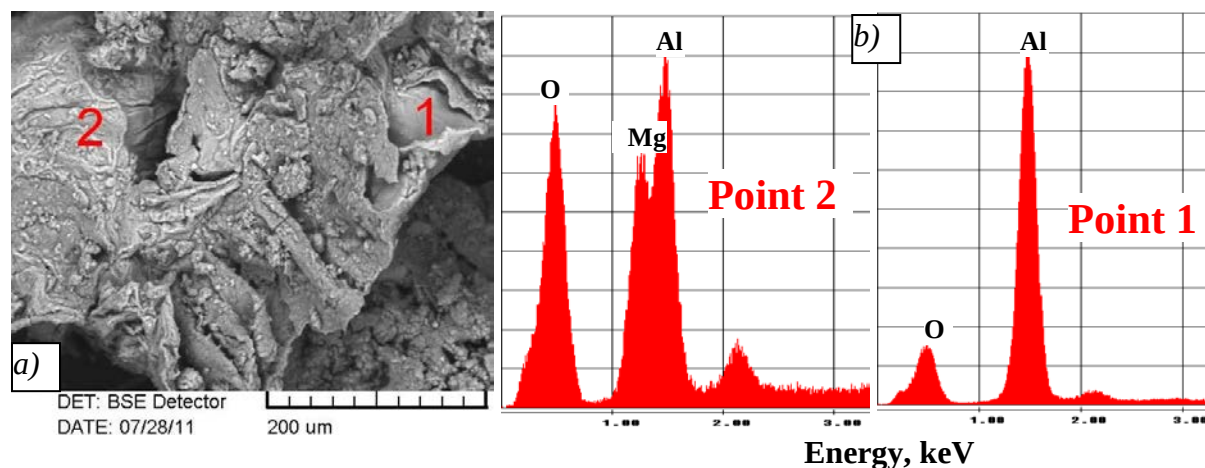


Fig. 10 Surface characteristics of a grain from the fine powder fraction of the treated Al – high Mg dross (a – SEM image, b – EDX spectra at the marked points of the grain surface)

The exothermic oxidation process may also result in local overheating, which was clearly indicated by the intensive light emission at the final stages of hot treatment applied to the Al-high Mg drosses. This effect in turn accelerates the Al_2O_3 γ - α transformation too, which breaks up the covering oxide layers, opening the fresh metal surfaces to the oxidising effects. On the other hand, the more inert α - Al_2O_3 component also reduces the dissolution rate of the

oxide coating in the NaOH reagent during the determination of the metal content in the fine powder fraction of the treated dross.

The existence of the complex magnesium aluminate spinel phases was proved by XRD examinations. Fig. 11 shows the relevant spectra and the phases found with the best alignment to the database. These results point out that Al, Al_2O_3 , MgO and MgAl_2O_4 are the dominant components in such drosses.

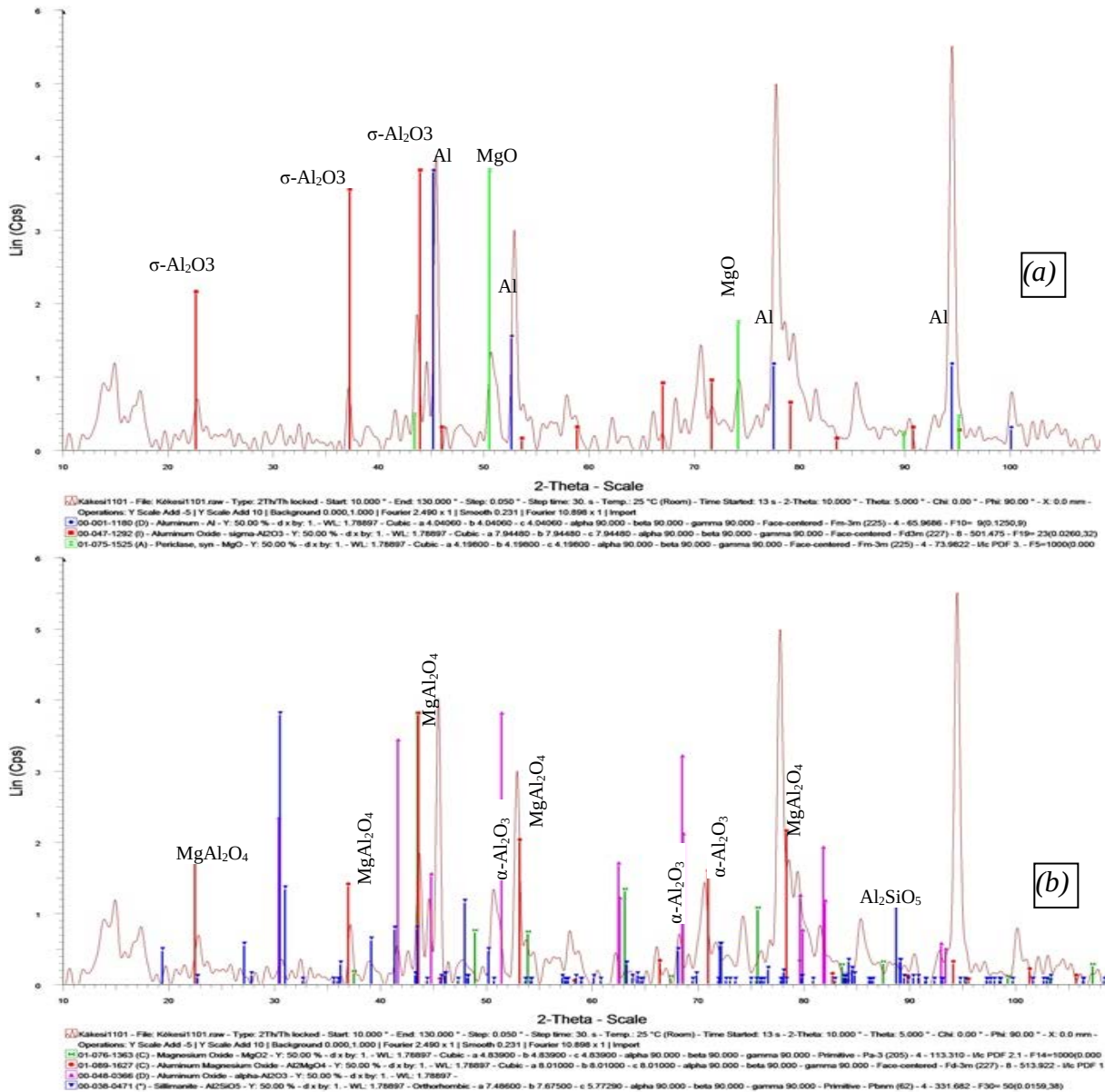


Fig. 11 The typical XRD spectrum of the fine powder fraction obtained by the treatment of Al-high Mg drosses (*a* – simple oxides and metal, *b* – complex oxides)

The surface of the grains in the fine powder obtained after grinding the treated dross collected from the melting of unalloyed aluminium is shown in Fig. 12. Comparing the images of Figs. 10 and 12 reveals a great difference. Instead of the wrinkled spongy structure, this dross particle is covered by a relatively thin oxide layer. The elemental composition in the characteristic points marked on the micrograph are shown by the corresponding EDX spectra.

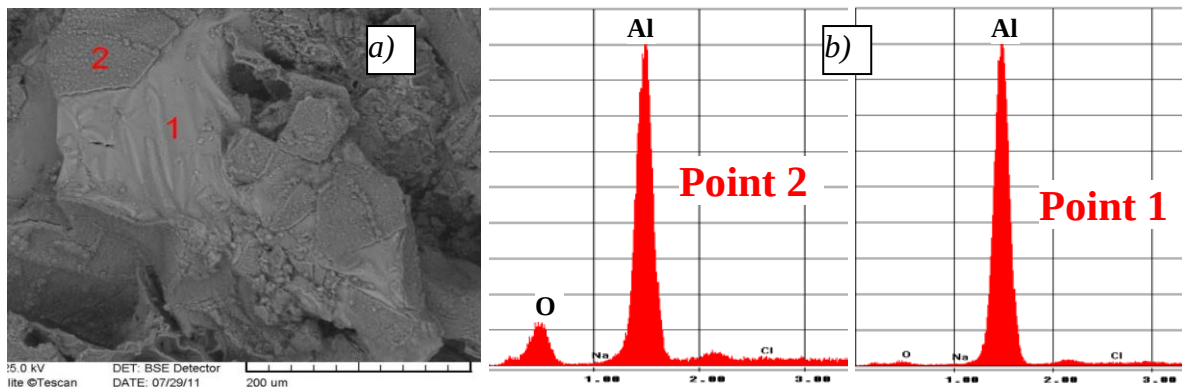


Fig. 12 Surface characteristics of a grain from the fine powder fraction of the treated Al dross (*a* – SEM image, *b* – EDX spectra at the marked points of the grain surface)

The thickness of the oxide layer covering the metal particle can also be determined from Fig. 12*a*. It is approximately 4.3 μm, and the structure is broken by the mechanical effect of fine grinding. Besides the deformed particles in this sample, solidified round metal micro-droplets can also be found. Fig. 13*a* shows that these microscopic particles can avoid the deformation of grinding and the surface oxide coating is relatively smooth, although locally of different thickness. While point 3 in figure 12*a* is virtually metallic Al, point 1 and point 2 are increasingly covered by the oxide. On the other hand, Fig 13*b* demonstrates that larger metal droplets may be liberated from the oxide cover by the impact of grinding forces.

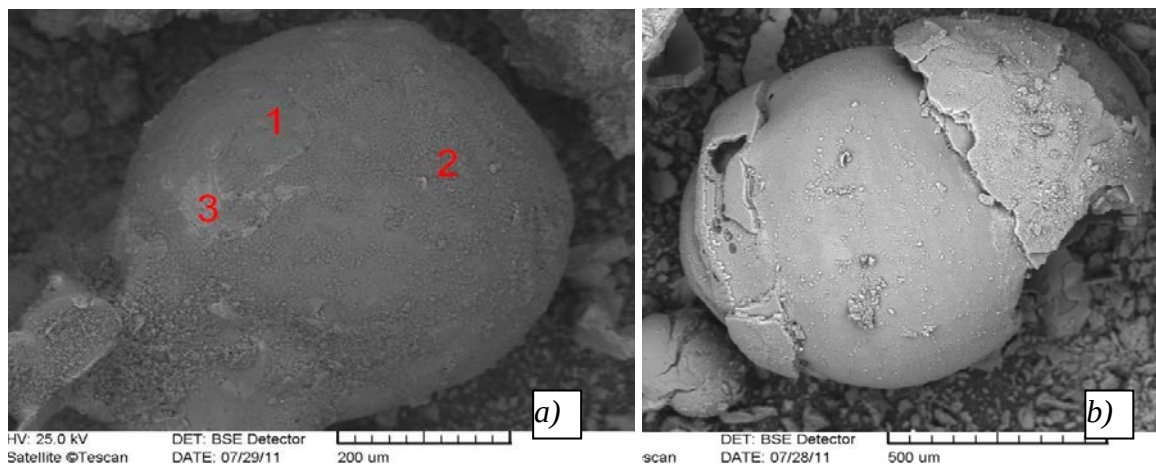


Fig. 13 Surface characteristics of a small Al droplets found in the fine powder fraction of the treated dross obtained from the melting of unalloyed aluminium

The fine particles of the Al dross obtained after grinding may constitute a suitable secondary raw material for further metal recovery or for the production of oxide or hydroxide products by novel hydrometallurgical extraction procedures [10,11].

4. CONCLUSIONS

Examination of the possible effects governing the formation of dross during the melting process of aluminium scrap has pointed out the significance of the extension and the

conditions of its surface. The reactivity of aluminium makes oxidation highly likely at elevated temperatures and aluminium scrap consisting of thin pieces and large specific surface requires special provisions for efficient melting. Local overheating by the exothermic oxidation poses extra difficulty for avoiding severe metal losses. Magnesium alloying deteriorates the difficulties because of the increased affinity for oxygen and by the formation of MgAl_2O_4 type complex oxides which make the dross structure rough and spongy. Hot mechanical treatment of the dross samples obtained from the melting of magnesium and manganese alloyed, or unalloyed aluminium scrap, respectively, has shown that metal can be extracted to a rate of approximately 70-80 % of the total dross weight. The effect of moderate ($\sim 10\%$) salt addition is not negligible and fluoride containing mixtures may be counterproductive by exposing the surface of the small metal particles to oxidation during the hot treatment of the dross. Application of protective atmosphere can be warranted for treating Al- high Mg type drosses, however it can increase recoveries only by $\sim 3\text{-}5\%$. The common NaCl additive proved to be even more efficient than either the KCl-MgCl₂ based cover salt or the fluoride containing cleaning salt. The reaction of the sodium containing fluoride or sulphate compounds with the Al-Mg melt can increase the sodium concentration to several ppm level. The scanning electron microscopy and X-ray diffraction examinations confirmed the suggested effect of the Mg content on dross formation. Small metal droplets can be liberated by fine grinding after the hot treatment of Al drosses, making it possible to devise efficient hydrometallurgical processing methods for the residual materials.

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