Effect of Ni addition on electrograining properties in 1050 aluminum

Masaki Tanigawa*, Shinichiro Hosono*, Kozo Hoshino*

*Aluminum Research Deveropment, Moka Plant, KOBE STEEL, LTD.
15 kinugaoka, Moka-city, TOCHIGI 321-43, JAPAN

Abstract

1050 aluminum is generally used for lithographic printing plates by A.C electrograining in dilute acid to produce uniform grained surface. Electrograining behavior is affected by not only graining condition but also chemical composition of aluminum alloy. We studied about the effect of Ni addition on electrograining properties in 1050 aluminum. Small amount of Ni addition in 1050 aluminum improves current efficiency and uniformity of the grained surface. This effect is caused with the change of amount and composition of intermetallic compounds by Ni addition.

Keywords; 1050 aluminum, electrograining, current efficiency, intermetallic compounds

Introduction

In lithographic printing, 1050 aluminum plate or strip has been generally used as the substrates of printing plates. The surface of the aluminum substrates is grained for the two purposes; one is adhesion of photosensitive layer and the other is water and ink reception during offset printing process. The most popular method for graining is A.C. electrograining currently. This is because that grained surface obtained by A.C. electrograining has superior printing performance and this method is suited for the continuous treatment for strip.

As set forth above, the aluminum alloy has been required to provide uniform grained surface by A.C electrograining. In recent years, the improvement of productivity of the electrograining process has been also required. Therefore, aluminum alloy having high current efficiency has been needed.

As mentioned above, to controll electrograining behavior is important for printing plates. It is known from former studies that electrograining behavior is affected by graining condition(e.g. current density, A.C wave form, concentration of electrolyte and so on) [1 ~ 5] and chemical composition of aluminum alloy[6,7]. But there are a few report about effect of small amount of element addition on electrograining properties in 1050 aluminum alloy.

In this study, espesially, the effect of Ni addition on electrograining properties in 1050 aluminum is investigated and discussed.

Experimental procedure

At first, an aluminum ingot having chemical composition shown in Table 1 was homogenized at 590 ℃ for four hours. Subsequently hot rolling and cold rolling was performed. Then, after performing intermediate annealing at 400 ℃, further cold rolling was performed to produce aluminum alloy sheet specimen of 0.3mm thickness.

After specimen were degreased and desmutted, electrograining was carried out in 1.0%HNO_3 solution at 25 ℃, using a current density 50A/dm² and A.C. frequency 60Hz. Then after desumatting, the morphology of grained surface was observed by SEM. And current efficiency for disolving of aluminum was calculated by measurement of weight loss of aluminum during electrograining.

Si, Fe, Al and Ni in intermetallic compounds in each specimen were analyzed by the phenol residue method[8], then, amount and composition of intermetallic compounds were calculated. And, the open-circuit potential of the various alloys which have similar composition to the intermetallic compounds was measured in the electrolyte.

Table 1 Chemical composition of specimen

	Si	Fe	Ni	Al
standard	0.06	0.3	—	bal.
Ni addition	0.06	0.3	0.01 ~ 0.1	bal.
Fe addition	0.06	0.35 ~ 0.6	—	bal.

(wt %)

Results and discussion

Effect of Ni addition

Fig.1 shows the effect of Ni addition on current efficiency for disolving of aluminum. As amounts of Ni addition in an aluminum increase, current efficiency is improved. In the viewpoint of the surface morphology, the uniformity of pit initiation site and the homogenity of pit size are improved by Ni addition (Photo.1) . These effects of Ni addition make it possible to form uniform grained surface in shorter electrograining period and in lower electric power comsumption.

Change of intermetallic compounds

Most of Ni added in aluminum alloy is contained in intermetallic compounds and amounts of Ni in solid solution are very little (less than 0.005wt%, it corresponds to solid solubility of Ni in Al[9]) . Intermetallic compounds in aluminum alloy act as starting points of initial pits during electrograining. Therefore, it is important to know the change of intermetallic compounds by Ni addition.

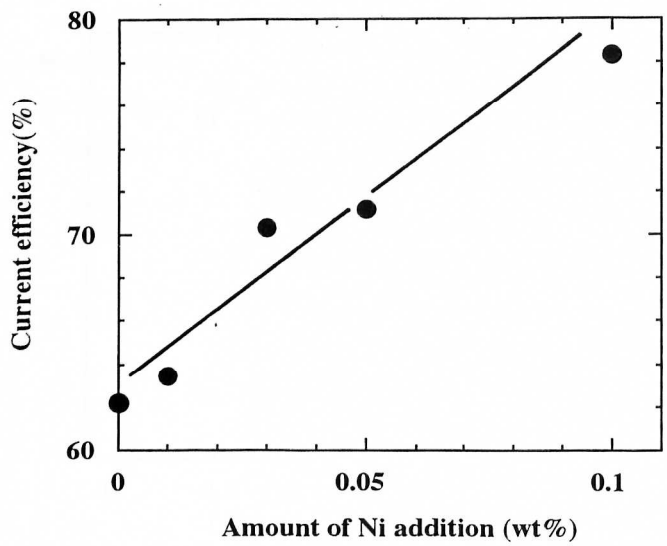

Fig.1 Effect of Ni addition on current efficiency for disolving of aluminum

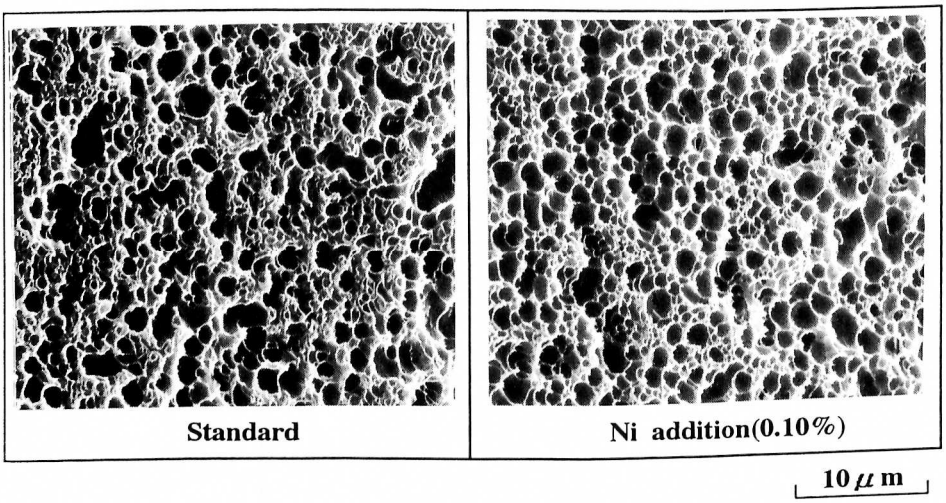

Photo.1 Morphology of grained surface by A.C. electrograining (Amount of charge 500c/dm^2)

Fig.2 shows the relation between Ni+Fe content and amounts of intermetallic compounds. As total content of Ni+Fe increases, amounts of intermetallic compounds increase. And the influence of Ni is same as that of Fe. Fig.3 shows the influence of Ni addition on composition of intermetallic compounds. In case of Fe added alloys, the composition of the compounds is fixed about 65%Al-35%Fe independing on Fe content. On the other hand, in case of Ni added alloys, Ni content in the compounds increases depending on Ni content in aluminum alloy.

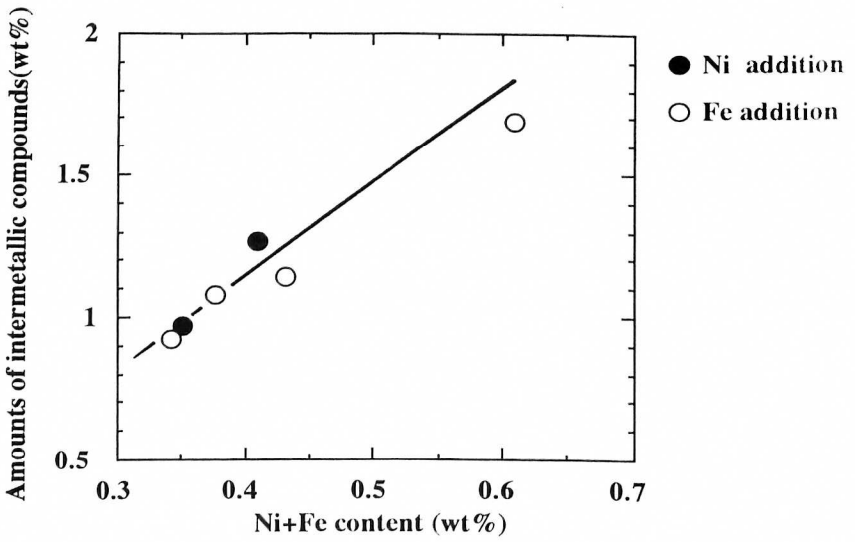

Fig.2 Relation between Ni+Fe content and amounts of intermetallic compounds

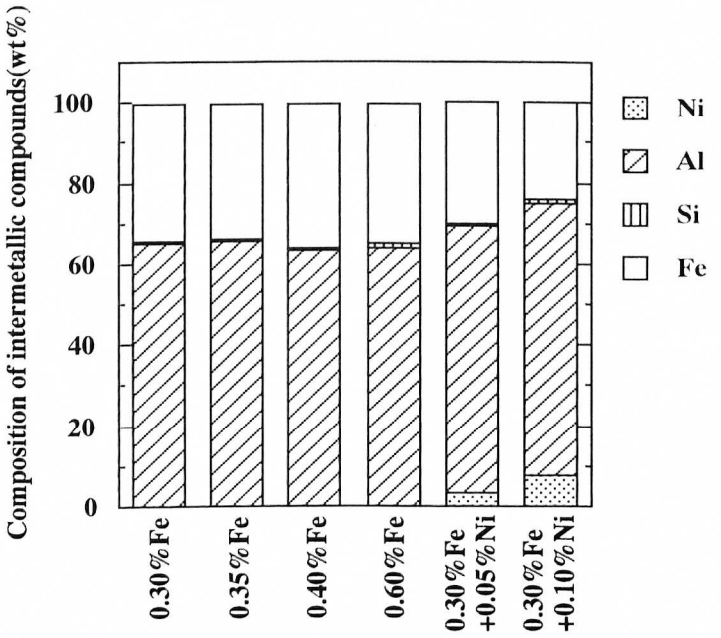

Fig.3 Influence of Ni addition on composition of intermetallic compounds

Chemical composition of the compounds is about 65%Al-35%(Fe,Ni). These results show that the compounds are shifted from Al_3Fe to $Al_5(Fe,Ni)$ by Ni addition. Fig.4 shows the effect of amounts of intermetallic compounds on current efficiency for disolving of aluminum. Current efficincy is improved in proportion to increse of amounts of intermetallic compounds. And

current efficiency of Ni added alloy is higher than that of Fe added alloy at the same amounts of compounds. These results show that the improvement of current efficiency by Ni addition is caused by not only increase of amounts of intermetallic compounds but also change of composition of intermetallic compounds.

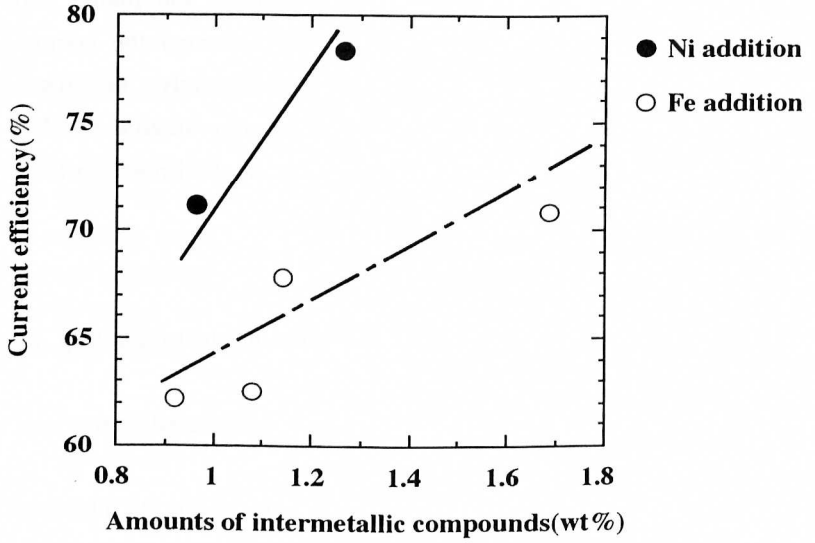

Fig.4 Effect of amounts of intermetallic compounds on current efficiency

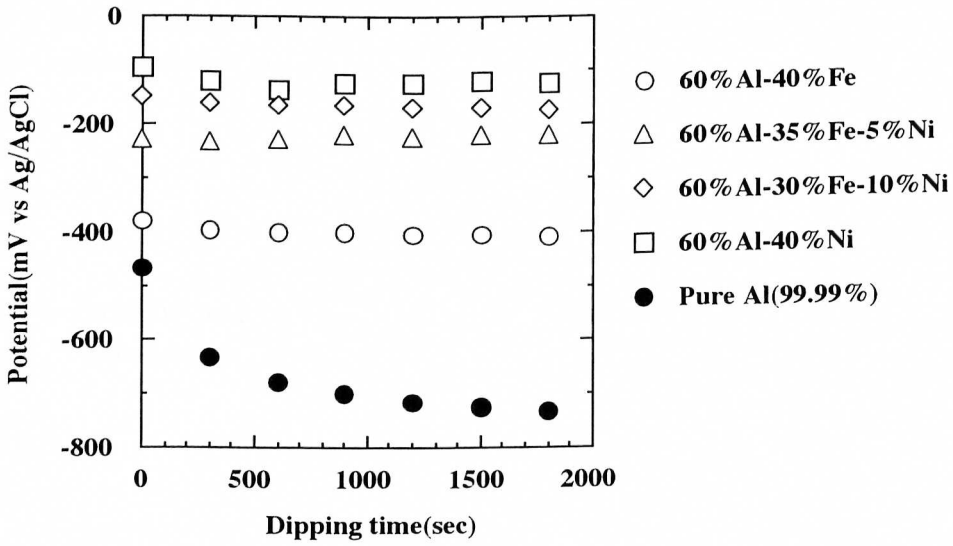

Fig.5 Open-circuit poential of various alloy

Fig.5 shows the open-circuit potential of each alloy having similar composition to intermetallic compounds. Potential of alloys containing Ni are noble compare to that of alloy corresponding to Al_3Fe (60%Al-40%Fe), and potential difference between intermetallic compounds and aluminum matrix increses by containing of Ni in intermetallic compounds. In general, potential difference between intermetallic compounds and matrix causes formation of local cell. Then, this phenomena makes aluminum matrix around the compounds which have relatively noble potential disolving preferentially. Consequently, the increase of potential difference between intermetallic compounds and aluminum matrix by Ni addition causes promotion of formation of etch-pit. This behavior results in the improvement of electrograining properties by Ni addition.

Conclusion

From this study of the effect of Ni addition on electrograining properties in 1050 aluminum, the following conclusions are obtained.

(1) As amounts of Ni addition in an aluminum increases, current efficiency and the uniformity of grained surface are improved.

(2) Intermetallic compounds are shifted from Al_3Fe to $Al_3(Fe,Ni)$ by Ni addition.

(3) The improvement of current efficiency by Ni addition is caused with not only increase of amounts of intermetallic compounds but also change of composition of intermetallic compounds.

(4) Intermetallic compounds containing Ni have noble potential than Al_3Fe and potential difference between intemetallic compounds and aluminum matrix increases.

Reference

[1] A.J.Dowell, Trans.IMF, 57(1979), 138

[2] H.Terryn, J.Vereecken and G.E.Tompson, Trans.IMF, 66(1988), 116

[3] T.H.Vereecken, Corros.Sci., 32(1991), 1173

[4] P.Laevers, H.Terryn and J.Vereecken, Trans. Inst. Metal Finish, 70(1992), 105

[5] B.Kernig, B.Grzemba, G.Scharf, Trans. Inst. Metal Finish, 70(1992),190

[6] A.J.Dowell, Trans.IMF, 64(1986), 85

[7] G.J.Marshall and J.A.Ward, Mater.Sci.Technol., 11(1995), 1015

[8] K.Sato and I.Izumi, BUNSEKI KAGAKU, 33(1984), 495

[9] HANSEN, CONSTITUTION OF BINARY ALLOYS, (1958)