Potentials of Magnesium Refining Through Intermetallic Precipitation

1. Motivation

- Recycling of Mg scrap leads always to pick up undesired elements such as Fe, Cu, Ni and Co
- Such impurities reduce the corrosion resistance of Mg-alloys even at low concentrations (Fig. 1)
- Except for Fe there is currently no procedure to remove these impurities from Mg- alloys
- Some elements e.g. Zr, Ca and Ti have been seen to bind intermetallic with impurities like Cu

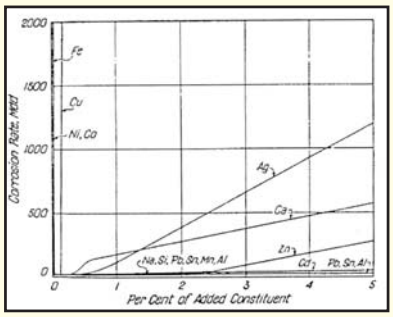


Fig 1: effect of some elements on the corrosion rate of magnesium

2. Material and Equipments

- Commercial magnesium alloys used for investigations:

Mg-alloy	Al(%)	Zn(%)	Mn(%)	Si(%)	Fe(%)	Cu(%)	Ni(%)	Others (%)
AZ31	2.6-3.5	0.7-1.4	0.2-1.0	max. 0.30	max. 0.01	max. 0.05	max. 0.001	Max. 0.05
AM50	4.5-5.3	max. 0.20	0.28-0.50	max. 0.05	max. 0.004	max. 0.008	max. 0.001	max. 0.01

- Synthesis of "mother alloys" from above alloys and 1% Cu
- Synthesis of magnesium "master alloys" with precipitation elements (Zr, Ca)
- Ti-Sponge

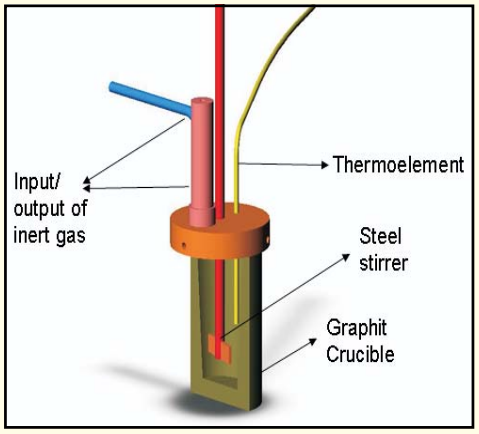


Fig. 2: ca. 280 ml graphite crucible equipped with a stirrer and inpur/output of inert gas sampling after slow solidification (12h) from the bottom and top area

3. Methodology of Experiments

- The conversion temperature of each mother alloy has been determined through DTA
- Each of the "mother alloys" were melted separately with the master alloys Mg-Ca and Mg-Zr, held at ca. 10°C higher than conversion temperature and then cooled slowly in the furnace (Fig. 2)
- The AZ31+1wt%Cu was melted while pieces of Ti-sponge were suspended in the melt via stirring (Fig. 2)
- The samples were studied through ICP chemical method as well as through metallography and SEM/ EDAX

4. Chemical Analysis

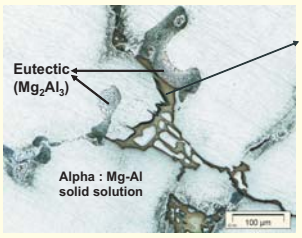
- Composition (wt%) of Mg-alloys treated with Ca respectively Zr for Cu precipitation:

AZ31-Cu-Ca	Al(%)	Zn(%)	Mn(%)	Si(%)	Fe(%)	Cu(%)	Mg(%)
	3.02	0.889	0.391	0.0240	0.0110	0.896	94,8

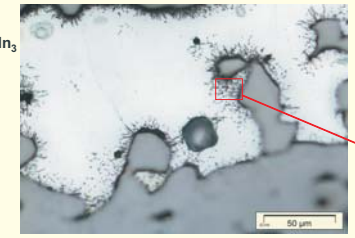
AZ31-Cu-Zr	Al(%)	Zn(%)	Mn(%)	Si(%)	Fe(%)	Cu(%)	Mg(%)
	3.31	0.797	0.336	0.0120	<0.00120	0.714	95.3

- Final Cu content of AZ31after 2h stirring with Ti-sponge: 0.85 wt%

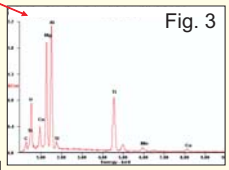
5. Metallography and SEM Results

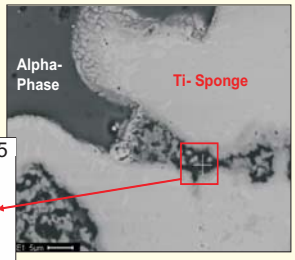


AM50-Cu-Ca
bottom sample

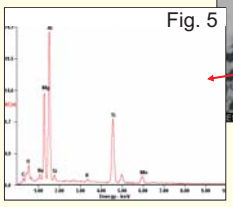


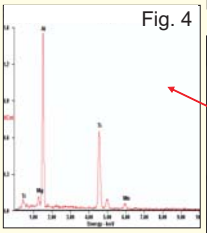
AZ31-Cu-Ti
top sample



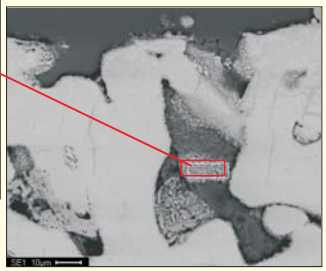


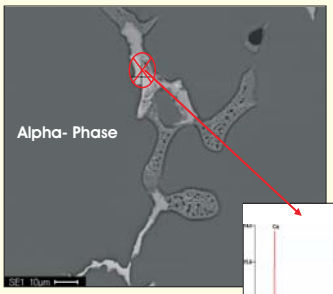
AZ31-Cu-Ti
top sample



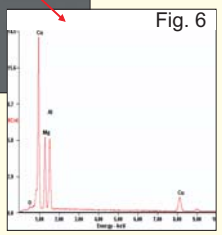


AZ31-Cu-Ti
top sample





AZ31-Cu-Ti
bottom sample



6. Assessment & Conclusions

- Aluminium existed in the alloy has formed compositions with Ti (probably intermetallic phases- see Fig. 3-5) and therefore copper was not attracted by Ti
- Probably copper can be removed through natural segregation if the melt is solidified very slowly based on the findings, where it was found precipitated at the bottom of the crucible (see Fig. 6)

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