

TUESDAY, AUGUST 24, 2004, A.M.

SESSION 18: INTERNATIONAL SYMPOSIUM ON LIGHT METALS AND METAL MATRIX COMPOSITES

CASTING AND SOLIDIFICATION

Sponsor: Light Metals Section, The Metallurgical Society of CIM

Room: 203

Chairmen: R. GHOMASHCHI, UQAC, Chicoutimi, Québec, Canada, and
J.-P. MARTIN, NRC-Aluminium Technology Center, Chicoutimi, Québec, Canada

PAPER 18.1 — 8:30

ON THE DETERMINATION OF THE NUCLEATION AND GROWTH ACTIVATION ENERGIES USING CALORIMETRIC DATA.

L.A. ANESTIEV, D. MALAKHOV, G. PURDY, McMaster University, Hamilton, Ontario, Canada

A method based on the use of the calorimetric data for determination of some kinetic parameters necessary for the modeling of the solidification processes is proposed. The method incorporates recent theories of nucleation and growth and allows modeling the heat flux release as it is measured at real calorimetric experiment. This allows using nonlinear regression analysis to retrieve the required kinetic parameters directly from the calorimetric data. The method is applicable on pure substances and on alloy systems. The obtained data shows very good agreement with the experimental data and theoretical predictions of other authors.

PAPER 18.2 — 8:55

AN OVERVIEW OF R & D ACTIVITIES ON GRAVITY, LOW PRESSURE AND LOST FOAM CASTING OF MAGNESIUM-BASE ALLOYS AT CANMET-MTL.

J.P. THOMSON, F.A. FASOYINU, M. SADAYAPPAN, D. EMADI and M. SAHOO, CANMET, Ottawa, Ontario, Canada

Magnesium alloys are steadily improving their market share as structural components especially in the transportation sector. Therefore, there is a great deal of interest from the automotive and the metal casting industry to develop viable economic casting processes for magnesium-base alloys. This paper summarizes the preliminary results on the continuing projects within CANMET-MTL on casting processes such as gravity and low pressure casting in sand and permanent molds and lost foam

PAPER 18.3 — 9:20

THE IMPROVEMENT OF MELT QUALITY AFTER IN-SITU PRECIPITATION OF Al_3Ti PARTICLES IN $AlTi$ ALLOYS.

S. SRIMANOSAOWAPAK and K. O'REILLY, University of Oxford, Oxford, United Kingdom

Melt cleanliness of $Al-0.4wt\%Ti$ was investigated at $790^\circ C$ using a PrefilTM filtration system. Two methods were used to improve melt cleanliness of the starting material (i) filtration using a 10ppi ceramic filter, and (ii) a novel in-situ precipitation technique. Filtration and in-situ precipitation improved the melt cleanliness by factors of 1.13 and 1.56 respectively, while increasing the grain size (as measured using standard TP1 tests) by factors of 1.14 and 1.36 respectively. The possible origins of the effects of these treatments on melt quality are discussed.

PAPER 18.4 — 9:45

INVESTIGATION OF INTERACTION BETWEEN Al/Mg ALLOYS AND ALUMINA PARTICLES.

G. ERGIN, D. KOCAEFE, Y. KOCAEFE, University of Québec at Chicoutimi, Chicoutimi, Québec, Canada,

D. EMADI and V. GERTSMAN, CANMET, Ottawa, Ontario, Canada

The interactions taking place between the Al/Mg alloy and the bed media during filtration are not well understood. These interactions were studied using the infiltration technique. The reaction interface was analyzed using different techniques such as SEM and TEM. Effects of type of alumina, Al/Mg alloy composition, and contact time were investigated. This paper discusses the results of this study.

COFFEE BREAK — 10:10 – 10:40

PAPER 18.5 — 10:40

THERMAL ANALYSIS AND MICROSTRUCTURAL EVALUATION OF INTERMETALLIC COMPOUNDS FORMED DURING PRE AND POST-EUTECTIC REACTIONS IN 319 ALUMINUM ALLOY.

S.G. SHABESTARI and S. GHODRAT, Iran University of Science and Technology (IUST), Narmak, Tehran, Iran,

Thermal analysis is a tool that is generally employed to predict the structure of the alloy before the actual casting is carried out. By cooling a sample of the molten alloy and recording the temperature-time curve, important solidification events may be analyzed by using the first derivative-cooling curve. In this research different levels of strontium are added to (AS₅U₃G) 319 aluminum alloy and their influence on the formation of intermetallic compounds e.g. Al₁₅(Mn,Fe)₃Si₂, Al₂Cu, Al₅Mg₈Cu₂Si₆ formed during pre- and post-eutectic reaction have been investigated. Also any changes in solidification parameters such as temperature of Al-Si eutectic under cooling and temperatures of nucleation and growth of each phases caused by strontium addition, have been determined via the first derivative cooling curves. The effect of different levels of strontium on the formation of various intermetallic compounds has been studied by using very accurate thermal analysis equipment and the microstructures were analyzed using an optical microscope. The various phases reported in this paper were identified using Scanning Electron Microscopy (SEM) and linked to Energy Dispersive Spectroscopy (EDS). Formation of all pre- and post-eutectic phases was interpreted by comparing the phases formed in the microstructure and the reactions detected by using cooling curves. The results of this research indicate that thermal analysis technique can be used as an on-line process control in the production lines in aluminum casting industries.

PAPER 18.6 — 11:05

THERMAL ANALYSIS STUDY OF THE EFFECT OF COOLING RATE ON THE MICROSTRUCTURE AND SOLIDIFICATION PARAMETERS OF 319 ALUMINUM ALLOY.

S. SHABESTARI and M. MALEKAN, University of Science and Technology, Tehran, Iran

In the metal casting industry an improvement of component quality mainly depends on better control over the production parameters. Thus, thermal analysis cooling curve of the alloy is used for process control in aluminum casting industry. Cooling rates of the alloy during solidification process affect microstructure, grain size, eutectic silicon morphology, and dendrite arm spacing (DAS). In this research, effect of cooling rate on the microstructure and solidification parameters of 319 aluminum alloy that is a widely used alloy in automotive industry, has been investigated by means of thermal analysis. Seven different cooling rates have been obtained by using CO₂-bonded silica sand molds with two different wall thicknesses, hot-work tool steel molds (H13) with and without coating, thin-wall steel molds with different coatings. In each case, cooling curve and first derivative cooling curve have been plotted by use of very accurate thermal analysis equipment. Effect of different cooling rates on solidification parameters e.g. Nucleation temperature (TN), nucleation under cooling (DTN); recalescence temperature (TR_{cl}), and growth temperature (TG) have been studied in the liquidus region. Micro structural evaluation has been carried out and DAS were measured in all solidification conditions. A numerical equation was proposed to predict cooling rates via measuring DAS in 319 aluminum alloy. Nucleation process and the effect of cooling rate have been interpreted by using thermal analysis cooling curves and micro structural study.