



Influence of remelting on AlSi_9Cu_3 (Fe) alloy properties

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Abstract

The focus of casting production on raw materials as a starting point of all industrial value chains is more intense due to legislative and recently the difficulties faced by casting manufacturers. Critical (CRMs) and strategic raw materials (SRMs) are often indispensable inputs for a wide set of strategic sectors including renewable energy, the digital industry, the space and defence sectors and health sector which are all connected to the metal industry. Aluminium and its alloys plays an important CRMs and SRMs. Recycling has become a very important term for environmental protection as it reduces the carbon footprint of the foundry supply chain. The importance of recycling or the use of secondary or scrap raw materials is demonstrated by the fact that only 5% of greenhouse gases are released in the production process compared to the production of primary aluminium. Standard aluminium alloy $\text{AlSi}_9\text{Cu}_3(\text{Fe})$ (EN AC 46000) is widely used in the automotive and transport industry. High mechanical properties such as strength and hardness, as well as elongation and corrosion resistance are the main advantages of $\text{AlSi}_9\text{Cu}_3(\text{Fe})$ alloy. The quality of an alloy is mainly influenced by the properties of the raw material, the melting treatment and the casting technology. The significant use of secondary, i.e. recycled raw material and also of CRM, requires special attention to the chemical composition due to possible deterioration caused by repeated remelting, which can lead to a deterioration of mechanical and other performance properties. A prerequisite for good functional properties is the development of the microstructure. In this work, the influence of completely returned material (secondary raw material—scrap) as the only input charge material for the production of $\text{AlSi}_9\text{Cu}_3(\text{Fe})$ alloys by remelting on the development of the microstructure due to thermodynamic interactions of elements present was investigated. The presence of wide range of alloying elements $\text{AlSi}_9\text{Cu}_3(\text{Fe})$ alloys indicates development $\alpha\text{-Al}_{15}\text{Si}_2\text{M}_4$ ($\text{M} = \text{Cr}, \text{Fe}$ and Mn), $\beta\text{-Al}_5\text{FeSi}$, Al_2Cu and even more complex one such as $\text{Al}_3\text{Cu}_2\text{Mg}_9\text{Si}_7$ using theoretical modelling. Complex solidification path indicates primary aluminium α_{Al} , eutectic phase $\alpha_{\text{Al}} + \beta_{\text{Si}}$, intermetallic phase on the iron base in Al_5FeSi and “Chinese script” morphology, intermetallic phase on the magnesium and copper base such as Al_2Cu and complex intermetallics such as $\text{Al}_3\text{Cu}_2\text{Mg}_9\text{Si}_7$ phase. Thermodynamic effects of elements interaction during solidification sequence significantly influence on solidification path and manner. Although the investigated samples exhibit high tensile strength and elongation, a slight deterioration of the chemical composition, and therefore in thermodynamic effect, has a significant influence on the development of the microstructure. Despite the deterioration of chemical composition, obtained microstructure was correct and, therefore, justified achieved high mechanical properties. Based on the investigation of the thermodynamic, microstructural and mechanical properties of the secondary $\text{AlSi}_9\text{Cu}_3(\text{Fe})$ alloy, the completely return raw material was characterised as a high-quality charge material with good application and recycling potential.

Keywords Recycling potential · Quality · $\text{AlSi}_9\text{Cu}_3(\text{Fe})$ alloy · Solidification · Thermodynamics · Microstructure

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Introduction

The carbon footprint of Europe's primary production process is 6.8 kg of CO₂ emissions compared to the global average of 16.1 kg CO₂ per kg of aluminium produced [1]. Raw materials are considered as an origin of all industrial value chains. These critical raw materials (CRMs) represent an indispensable input for a strategic sector such as renewable energy, the digital industry, the space and defence sectors and the health sector, most of them connected to metal industry. Extraction and processing of CRMs can have negative environmental impacts, depending on the methods and processes used, as well as social impacts. Recently, development of emerging economies and the diffusion of key enabling technologies dictate the demand for raw materials. The criticality of aluminium is assessed for two different life cycle stages, the extraction and refining. Aluminium application is approximately 74% in total for NACE sector C25—Manufacture of fabricated metal products, except machinery and equipment consist from construction, automotive industry and transport equipment and packaging [2].

Strategic importance for economic growth and the sustainability of Europe's economy and society including the transition to climate neutrality and a digital economy while complying with the principle of do no significant harm as stated in the European Green Deal deals with sustainable raw materials extraction and processing in which they [3]: 1) contribute to the economic growth and socio-economic advancement of communities; 2) ensuring the long-term sustainability and economic viability to develop and meet the mineral and metal needs of modern society; 3) facilitate innovation and promote the adoption of digital technologies for safer, cleaner and more cost-efficient production processes; 4) implement circular and resource-efficient mineral-based technology value chain to promote waste recovery, and enable energy transition and electrification.

Since aluminium and its alloys belong to the group of green materials and due to its recognises significance in the CRMs and SRMs, the potential of its' use as a secondary raw material is enormous. Usual application of secondary raw material in conventional foundries was dedicated to own return (scrap) [4, 5]. Controlled features such as chemical composition and level of impurities enable addition of higher amount of aluminium scrap in production of aluminium alloys [6, 7].

Recycling has become a very important term for environmental protection as it reduces the carbon footprint of the foundry supply chain. The importance of recycling or the use of secondary or scrap raw materials is demonstrated by the fact that only 5% of greenhouse gases are released in the production process compared to the production of

primary aluminium. Reliability and sustainability of the casting processes and the availability of raw materials classified by quality and footprint, as well as energy savings of up to 95%, are also important proofs of quality for the end product (casting) [8–10]. Aluminium and its alloys belong to the group of green materials, and the most reliable secondary raw material in conventional foundries with the lowest footprint is its own return (gating and feeding system, scrap).

The standard aluminium alloy AlSi₉Cu₃(Fe) (EN AC 46000) is widely used as a safety-critical material in the automotive and transport industries and is subject to high demands on its functional and mechanical properties such as high strength at room and elevated temperatures [9–17]. The required chemical composition does not always allow the replication of the microstructure and thus the development of the mechanical properties due to a number of element interactions and the applied technological production parameters [10, 11, 17–19]. These are mainly influenced by the properties of the raw material, the melting treatment and the casting technology. The significant use of secondary, i.e. recycled raw materials and also CRM, requires special attention to the chemical composition due to possible degradation by repeated remelting, which can lead to a deterioration of mechanical and other performance properties.

Multiple remelting is an important aspect in extending the material end of life. Understanding of microstructure evolution during solidification is of general importance due to requirements related to mechanical, technological and corrosion properties of material [20, 21]. Beside melt treatment, cooling rate and heat treatment, it is mainly dependent from the chemical composition and possible interaction of present elements during solidification process [22, 23]. Numerous interactions occurred during solidification process. Modelled equilibrium phase diagram enables solidification sequence prediction in equilibrium and non-equilibrium mode [21–23]. Microstructural investigation of samples by optical and scanning electron microscopy confirms the presence of following phases: primary aluminium evolution (α_{Al}), iron base phases (Al₅FeSi, Al_x(Fe,Mn,Cu)_ySi_z and/or Al_x(Fe,Mn)_yMg_zCu_uSi_w), primary eutectic phase ($\alpha_{Al} + \beta_{Si}$), secondary eutectic phases in the form of intermetallic phases such as Al₅Mg₈Si₆Cu₂, Al₂Cu and finally Al₁₅Cu₂Mg₈Si₆.

In this work, the influence of completely returned material (secondary raw material—scrap) as the only charge material for the production of AlSi₉Cu₃(Fe) alloys by remelting on the development of the microstructure due to thermodynamic interactions of present elements was investigated. The quality assessment of the charge material was based on the degeneration of the chemical composition due to remelting, a possible change in the solidification

sequence and/or the characteristic temperatures of phase transformation and precipitation and consequently on the influence on other functional properties of the final products.

Materials and methods

Recent practice in high-pressure die casting (HPDC) foundries is designing the charge materials with 50% of return and 50% of new raw materials (conventional charge material—CCM). In this work, the charge material for melting was prepared from 100%, i.e. completely return material (return charge material—RCM).

Specially designed tool for casting of AlSi₉Cu₃(Fe) alloy test samples according to ISO 377, ISO 6892–1 and ISO 1099 standards were produced using HPDC technology at BUHLER 53D machine. Casting and robotised coating with watertight coatings were carried out in a fully automated cycles, and samples were cooled in the air. Obtained samples undergone the mechanical properties investigations performed on testing machine MTS 810, at room temperature $T = 20\text{ }^{\circ}\text{C}$ in accordance with EN 10002–1 [23].

Transformation temperatures were obtained by simultaneous thermal analysis, differential scanning calorimetry/thermogravimetry, with instrument STA DSC/TG, NETZSCH Jupiter 449 F1. Temperature and sensitivity calibration files were created with measurements of eight different pure materials: In, Sn, Bi, Pb, Zn, Al, Ag and Ni. The resolution of DSC instrument was $1\text{ }\mu\text{m}$ and temperature resolution 0.001 K . Base line was determined with alumina pans. Dynamic measurements were performed in temperature interval from $25\text{ to }710\text{ }^{\circ}\text{C}$, in argon atmosphere, with heating/cooling rate of $10\text{ }^{\circ}\text{Cmin}^{-1}$. Measurements were repeated 2 times, and results of the second measurement were presented as referent obtained values.

Chemical composition analysis was performed using optical emission spectrometer ARL-3460. Thermodynamic calculations of equilibrium and Scheil–Gulliver non-equilibrium phase diagram of AlSi₇MgCu alloy have been performed by Thermo-Calc software TCW 5.0, with database TTAL7. Obtained results were compared with those from simultaneous thermal analysis performed on STA 449 F1.

STA enables determination of characteristic temperatures and thermal effect of particular events during melting and/or solidification.

The microstructure was examined with a light OLYMPUS BX51 and scanning electron microscope JEOL-5610 equipped with energy-dispersive spectrometer Oxford type.

Results and discussion

Analysis of chemical composition

The chemical composition of AlSi₉Cu₃(Fe) alloy is given in Table 1. The comparison of the chemical composition of tested samples with certified data showed no deviations from the values required by the standard EN 1706 [24].

Comparison of requirement and tested samples in conventional charge material (CCM 50%) and recycled—return charge material (RCM 100%) revealed that all obtained values for important elements are consequent with the norm but lower in return charge material. Due to the high values of copper and low content of magnesium, the formation of Al₂Cu and Al₃Cu₂Mg₉Si₇ intermetallic phases is expected. With respect to the corresponding content of iron and manganese in the tested RCM alloy, and due to applied HPDC technology, Al₁₅Si₂M₄ (M = Cr, Fe and Mn) phase formation is expected. Other impurities, lead, chrome and tin, are within the limits prescribed by norm.

Thermodynamic modelling results

Thermodynamic modelling enables equilibrium and non-equilibrium prediction of solidification sequence according to chemical composition [15]. Figure 1 indicates modelled behaviour of conventional and return charge material on the base of thermodynamic parameters present elements. Thermodynamic modelling enables prediction and comparison of solidification sequence and associated temperatures of phases' transformations and evolution.

Evaluation and comparison of obtained equilibrium and non-equilibrium phase diagram of both charge materials revealed differences in solidification sequence. Reactions in solidification sequence of tested AlSi₉Cu₃ (Fe) alloys made

Table 1 Comparison of chemical composition of charge material EN AB AlSi₉Cu₃ by EN 1706:2020 standard, conventional charge material consisted from 50% and return charge material consisted from 100% of return charge material

ELEMENT w/mass%	Si	Fe	Cu	Mn	Mg	Cr	Zn	Pb	Sn
EN 1706	8.0–11.0	1.0	2.0–4.0	0.55	0.05–0.55	0.15	1.2	0.35	0.25
CCM (50%)	9.75	0.89	3.26	0.24	0.12	0.04	0.99	0.06	0.012
RCM (100%)	8.75	0.66	2.91	0.20	0.17	0.04	0.82	0.04	0.004

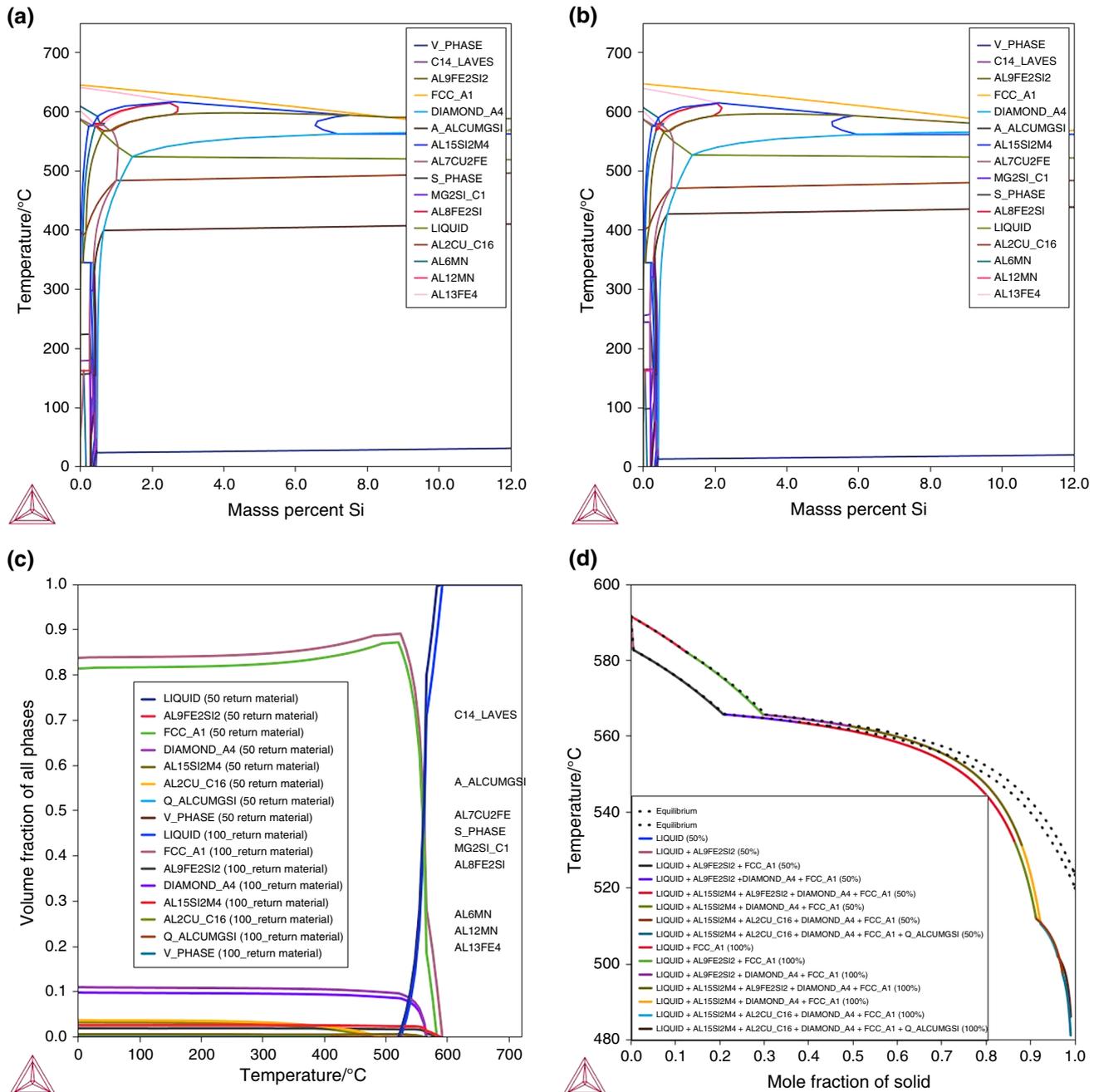


Fig. 1 Evaluation and comparison of solidification sequence of $\text{AlSi}_9\text{Cu}_3(\text{Fe})$ alloy from conventional and return charge material: **a** Al-corner of conventional charge material; **b** Al-corner of return charge material; **c** comparison of solidification sequence for both

charge materials in equilibrium phase diagram and **d** comparison of solidification sequence for both charge materials in non-equilibrium Scheil phase diagram

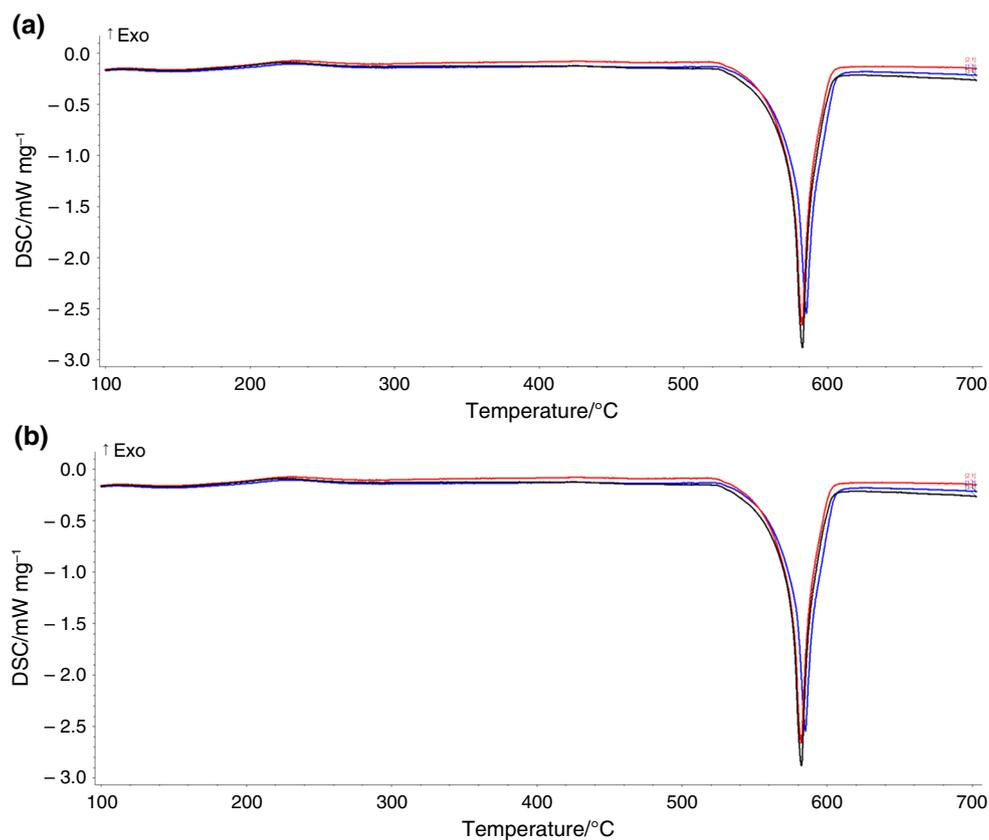
from different recycling ratios according to non-equilibrium Scheil diagram are as follows in Table 2.

The reactions in the solidification sequence of the two charge materials compared showed no differences in the reactions, the phases obtained and their order of occurrence. The main difference is in the associated temperatures and solidification intervals. The CCM $\text{AlSi}_9\text{Cu}_3(\text{Fe})$

alloy exhibits a wider solidification interval of 92.71°C , while the interval for the RCM is 89.10°C . Although the liquidus temperature is lower than for RCM, solidification with Fe phases starts earlier (582.12°C) and occurs at an interval of 50.77°C , while the interval for CCM is 51.11°C . The temperature difference in the development of the eutectic phase is only 0.07°C , although the

Table 2 Comparison of solidification sequence and characteristic temperatures for both charges of tested AlSi₉Cu₃(Fe) alloys

Charge material	Reaction	Temperature, /°C
Conventional charge material (CCM) (50% return material)	$L + \beta - Al_5FeSi$	590.62
	$L + \beta - Al_5FeSi + \alpha_{Al}$	583.53
	$L + \beta - Al_5FeSi + \alpha_{Al} + \beta_{Si}$	565.80
	$L + \beta - Al_5FeSi + \alpha_{Al} + \beta_{Si} + Al_{15}Si_2M_4 (M = Cr, Fe, Mn, Mo)$	563.77
	$L + \beta_{Si} + Al_{15}Si_2M_4 (M = Cr, Fe, Mn, Mo)$	532.42
	$L + \alpha_{Al} + \beta_{Si} + Al_{15}Si_2M_4 (M = Cr, Fe, Mn, Mo) + Al_2Cu$	512.39
	$L + \alpha_{Al} + \beta_{Si} + Al_{15}Si_2M_4 (M = Cr, Fe, Mn, Mo) + Al_2Cu + Al_3Cu_2Mg_9Si_7$	497.91
Return charge material (RCM) (100% return material)	$L + \alpha_{Al}$	591.62
	$L + \beta - Al_5FeSi + \alpha_{Al}$	582.12
	$L + \beta - Al_5FeSi + \alpha_{Al} + \beta_{Si}$	565.73
	$L + \beta - Al_5FeSi + \alpha_{Al} + \beta_{Si} + Al_{15}Si_2M_4 (M = Cr, Fe, Mn, Mo)$	562.70
	$L + \beta_{Si} + Al_{15}Si_2M_4 (M = Cr, Fe, Mn, Mo)$	531.35
	$L + \alpha_{Al} + \beta_{Si} + Al_{15}Si_2M_4 (M = Cr, Fe, Mn, Mo) + Al_2Cu$	511.32
	$L + \alpha_{Al} + \beta_{Si} + Al_{15}Si_2M_4 (M = Cr, Fe, Mn, Mo) + Al_2Cu + Al_3Cu_2Mg_9Si_7$	502.52

**Fig. 2** STA analysis of RCM AlSi₉Cu₃(Fe) alloy: **a** heating curve and **b** cooling curve

silicon content in RCM was reduced for 1 mass.%. Furthermore, the solidification of Fe phases in both materials starts with a needle-like β -phase. The preferred morphology until the end of solidification is $Al_{15}Si_2M_4$ ($M = Cr, Fe, Mn$ and Mo). In RCM, the development of the Cu and

Mg phases takes place in a narrower solidification interval ($511.32-502.52 = 8.8$ °C), while it is significantly wider in CCM ($512.39-497.91 = 14.48$ °C). Total solidification interval is 92.71 °C for CCM and 89.10 °C for RCM alloy. Based on the development and comparison of the

Table 3 Characteristic temperatures of phase transformations and evolution of $\text{AlSi}_9\text{Cu}_3(\text{Fe})$ alloy

Sample	$T_L/^\circ\text{C}$	$T_E/^\circ\text{C}$	$T_{\text{Al-Cu}}/^\circ\text{C}$	$T_{\text{S:Al-Cu-Mg-Si}}/^\circ\text{C}$	$\Delta T_{\text{L-S}}$
1	591.0	561.1	500.7	491.9	99.1
2	588.7	562.6	500.1	492.2	96.5
3	588.2	561.8	497.1	492.1	96.1

solidification sequences of both charge materials, there are no significant changes that could harmfully affect the desired functional properties.

Simultaneous thermal analysis results

Simultaneous thermal analysis (STA) was performed on several samples of completely RCM in order to estimate correspondence of solidification behaviour with previously modelled one. The heating and cooling curves shown in Fig. 2 show good matching for a number of samples.

Analysis of simultaneous thermal analysis heating/cooling curves indicates characteristic temperatures of phase transformations and evolution. Characteristic temperatures of phase changes and transformations are presented in Table 3.

An endothermic heating effect can be seen on the DSC curve during heating. The total enthalpy of the heating/melting process is in the endothermic range from -286.3 to -295.4 Jg^{-1} . During the heating study,

the liquidus temperature T_L is displayed in the range $588.2\text{--}591.0 \text{ }^\circ\text{C}$. During cooling/solidification process, three exothermic effects can be seen in the DSC curve. The STA investigation of the fully RCM $\text{AlSi}_9\text{Cu}_3(\text{Fe})$ alloy shows that the solidification sequence modelled by TCW is maintained. The enthalpy of the entire solidification process is in the exothermic range of $299.4\text{--}303.2 \text{ Jg}^{-1}$. The characteristic temperatures of phase transformation and precipitation during solidification are as follows: eutectic phase evolution at $T_E = 561.1\text{--}562.6 \text{ }^\circ\text{C}$, intermetallic phase Al_2Cu at $T_{\text{Al-Cu}} = 497.1\text{--}500.7 \text{ }^\circ\text{C}$ and the final solidifying phase $\text{Al}_3\text{Cu}_2\text{Mg}_9\text{Si}_7$ at $T_{\text{S:Al-Cu-Mg-Si}} = 491.9\text{--}492.2 \text{ }^\circ\text{C}$. A decrease of the eutectic T_E and the low-temperature phases $T_{\text{Al-Cu}}$ and $T_{\text{S:Al-Cu-Mg-Si}}$ are observed. The solidus temperature T_S is at least $10.32 \text{ }^\circ\text{C}$ lower than the modelled temperature, and the solidification interval is, therefore, larger at $7\text{--}10 \text{ }^\circ\text{C}$.

Microstructure investigation results

Microstructure development did not indicate any significant deviation from the solidification sequence as shown in Fig. 3.

Results of optical microscopy (OM) and scanning electron microscopy (SEI) show the typical microstructure of $\text{AlSi}_9\text{Cu}_3(\text{Fe})$ alloy produced by HPDC. Microscopy investigation reveals dendrite network of primary α_{Al} , needle-like, blocky and Chinese script iron phases (Al_3FeSi , $\text{Al}_{15}\text{Si}_2\text{M}_4$ ($\text{M} = \text{Cr, Fe and Mn}$)), primary eutectic phase ($\alpha_{\text{Al}} + \beta_{\text{Si}}$) and

Fig. 3 Microstructure of $\text{AlSi}_9\text{Cu}_3(\text{Fe})$ alloy: **a** optical microscopy image, detail 1, magnification 500X, **b** optical microscopy image, detail 2, magnification 500X, **c** scanning electron image, detail 1 and **d** scanning electron image, detail 2

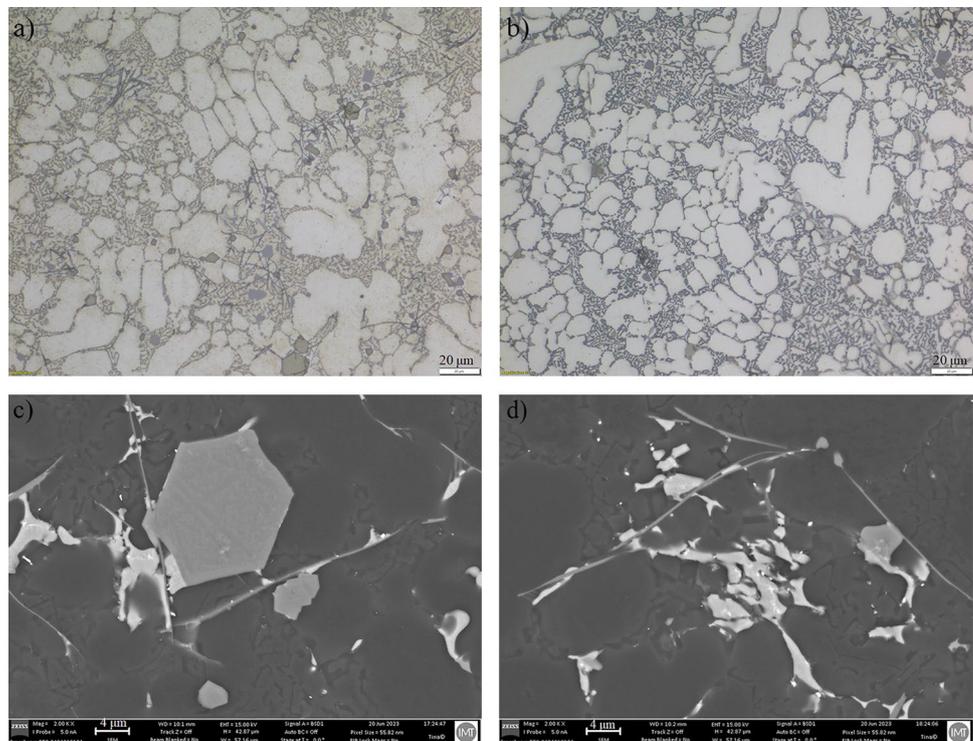


Fig. 4 Mapping microscopy of SEI detail 2

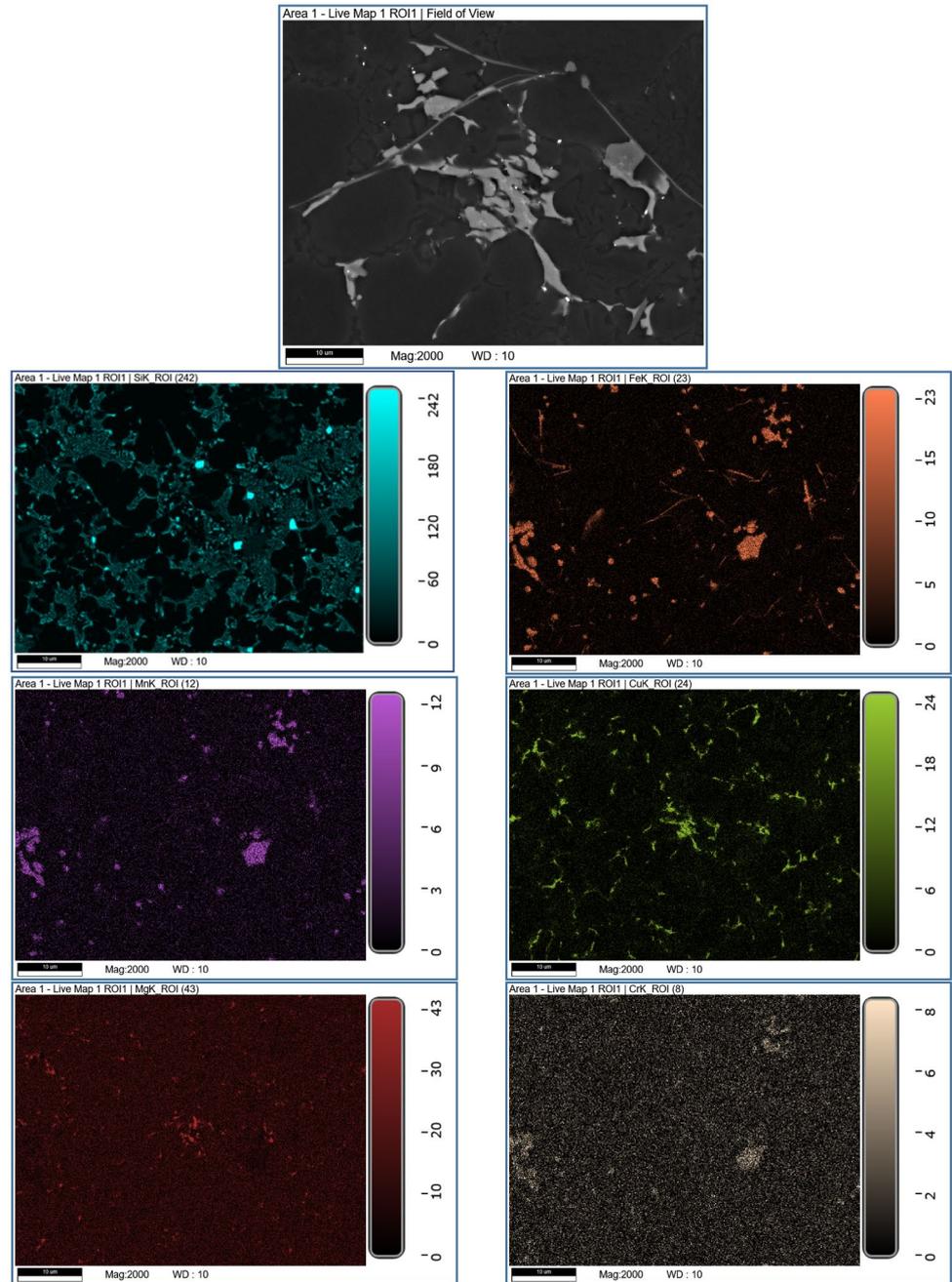
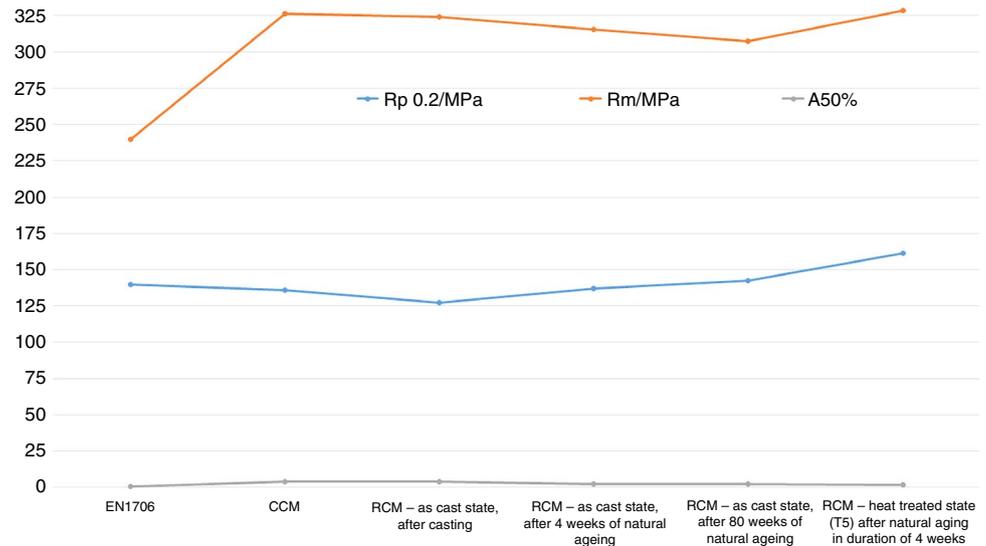


Table 4 Results of mechanical properties investigation of $\text{AlSi}_9\text{Cu}_3(\text{Fe})$ alloy

Sample	$R_{p0,2}/\text{MPa}$	R_m/MPa	$A_{50}/\%$
EN 1706	140.0	240.0	> 1.00
CCM (50%)	136.0	326.0	4.00
RCM—as-cast state, after casting	127.1	324.1	3.89
RCM—as-cast state, after 4 weeks of natural ageing	137.3	315.4	2.49
RCM—heat-treated state (T5) after natural ageing in the duration of 4 weeks	161.3	328.5	1.67

Fig. 5 Comparison of obtained mechanical properties for different states of $\text{AlSi}_9\text{Cu}_3(\text{Fe})$ alloy



other intermetallic phases such as Al_2Cu and $\text{Al}_3\text{Cu}_2\text{Mg}_9\text{Si}_7$. The microstructural components remain the same in return charge material as well as morphology of intermetallics. Mapping of SEI confirmed interaction of particular elements in characteristic phases' morphologies and therefore presence of calculated microstructural constituents as shown in Fig. 4.

Microstructure investigation consists from matrix of primary aluminium α_{Al} , eutectic phase $\alpha_{\text{Al}} + \beta_{\text{Si}}$, intermetallic phase on the iron base in predominantly needle-like morphology— Al_5FeSi and also in $\text{Al}_{15}\text{Si}_2\text{M}_4$ ($\text{M} = \text{Cr}$, Fe and Mn) in “Chinese script” morphology, and last solidifying phases' Al_2Cu and $\text{Al}_3\text{Cu}_2\text{Mg}_9\text{Si}_7$ on the copper base. Copper intermetallic phases are placed on the grain boundaries.

Mechanical properties results

Mechanical properties (yield and tensile strength) investigation of $\text{AlSi}_9\text{Cu}_3(\text{Fe})$ alloy consists from testing in as-cast state and 30 days after casting in order to indicate the influence of natural ageing of an alloy on mechanical properties and comparison to heat-treated sample according to T5 mode. Mechanical properties results are presented in Table 4.

A yield strength ($R_{p0.2}$) in conventional CCM (50%) alloy of 136 MPa was below the required value of 140 MPa specified in the EN 1706 standard. Even lower values of 127.1 MPa were achieved for RCM in the as-cast state, which was tested after casting. A slight improvement was achieved for the as-cast samples at 137.3 MPa after a natural ageing period of 4 weeks. The tensile strength (R_m) was higher than required by the EN 1706 standard in all observed cases. Only the samples that were subjected to an additional heat treatment in T5 mode after a natural ageing period of 4 weeks fully met the requirements of the EN 1706 standard

with regard to yield strength ($R_{p0.2}$). The elongation was many times higher than recommended in all cases tested.

Comparison of mechanical properties $\text{AlSi}_9\text{Cu}_3(\text{Fe})$ alloy samples from 100% of return charge material in as-cast, natural aged and heat-treated state versus request by EN 1706 standard is shown in Fig. 5.

The comparison of the mechanical properties obtained for different states of the $\text{AlSi}_9\text{Cu}_3(\text{Fe})$ alloy shows a good recycling potential of the remelted material, despite the reduction of the yield strength during the first remelting with a tendency to increase due to natural ageing. The remelted $\text{AlSi}_9\text{Cu}_3(\text{Fe})$ alloy shows good application potential due to the retention of the solidification sequence and the microstructure development.

Conclusions

Influence of RCM (remelted) $\text{AlSi}_9\text{Cu}_3(\text{Fe})$ alloy on solidification thermodynamics and microstructure development was investigated in this work. Investigation was performed on completely return charge material of $\text{AlSi}_9\text{Cu}_3(\text{Fe})$ alloy.

The STA investigation of completely return charge material of revealed follow-up of the $\text{AlSi}_9\text{Cu}_3(\text{Fe})$ alloy reveals follow-up of solidification sequence modelled by TCW. The lowering of eutectic and low-temperature phases' temperatures is noticed. Solidus temperature T_s is lower than modelled for 10.32 °C, and solidification interval is, therefore, wider for 7–10 °C.

The comparison of the chemical composition of samples from conventional (50% of the return) and recycled—return material (100%) showed that all obtained values correspond to the standard, but are slightly lower for return material. The modelling of the solidification sequence of the $\text{AlSi}_9\text{Cu}_3(\text{Fe})$ alloy for both charge materials revealed some differences in the solidification path regarding the characteristic temperatures

for the intermetallic phases based on Fe and Cu/Mg as the last solidification phases. Microstructure did not show significant deviation in development of main microstructure consists from primary aluminium α_{Al} , eutectic phase $\alpha_{\text{Al}} + \beta_{\text{Si}}$, intermetallic phase on the iron base in Al_3FeSi and “Chinese script” morphology, intermetallic phase on the magnesium and copper base such as Al_2Cu and complex intermetallic such as $\text{Al}_3\text{Cu}_2\text{Mg}_9\text{Si}_7$ phase. The microstructural components remain the same in return charge material as well as morphology of intermetallics. Microstructure development comprehends to relatively high values of mechanical properties regarding tensile strength and elongation, all in line to the standard requirements.

Thermodynamic and microstructural investigation results of the AlSi_9Cu_3 (Fe) alloy indicated completely return material as a quality charge material. In despite of chemical composition derogation, microstructure development was correct and, therefore, justified by achieved high mechanical properties. Despite the reduction in yield strength during the first remelting of AlSi_9Cu_3 (Fe) alloy, the results of investigation of return material as the only component of charge material represent this alloy as a quality charge material with good application potential.

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