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SCIENTIFIC PAPER

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THE CHARACTERIZATION OF TALC-BASED COATING FOR APPLICATION FOR Al-Si ALLOY CASTING

In this paper is presented, a correlation of the technological parameters of talc–based coating production and the silumine casting quality obtained by the Evaporate Pattern Casting Method. Special attention was paid to the correlation of refractory coating production, keeping in mind the requirements for application in foundry practice. For the evaluation of the obtained results, comparative examinations were performed with sand mould castings under the same conditions.

Key words: Talc, Refractory coating, Evaporate Pattern Casting Method.

Talc is magnesium hydrosilicate, its formula can be shown as $H_2Mg_2(SiO_3)_4$ or $Mg_6(OH)_4(Si_8O_{20})$ with Al_2O_3, FeO, NiO, CaO admixtures. Talc Moos hardness is 1, density 2.6–2.8 g/cm^3. It is used in many industries because of its characteristics– low hardness, adhesion capability (surface coating), high melting temperature, chemical inertnes, low electro conductibility, an exceptional ability to absorb fats, paints and resins and low hygroscopy [1].

Keeping in mind the characteristics of talc and the requirements for ceramic coatings to be used in the EPC Method, the idea arose to investigate the possible application of talc as a refractory filler in coatings. The EPC Method is a relatively new casting technology. In contrast to sand mould casting, this process uses patterns and gatings of moulds made of polymeride, the patterns staying inside up to metal pouring. In contact with the liquid metal, the polymeride patterns decompose and evaporate, and the cavity is filled with liquid metal. The process of polymeride decomposition depends on a great number of process factors. The technological parameters relevant for casting quality are polymeride pattern density, casting temperature, type and thickness of the pattern refractory coating, the permeability of the moulding sand, the gating of moulds. These process parameters are selected in accordance with the type of alloy and the kind of castings [2–4].

Pattern refractory coatings, depending on the casting alloy type, are complex mixtures of more than fifteen components, the four main components being:

– refractory powder, as a filler;
– liquid agent, or solvent;
– binding system;
– suspension stability agent.

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The main requirement for a quality coating includes the corresponding refractoriness, permeability for gaseous products of the pattern decomposition, easy application, drying and checking thickness of the pattern coating. The coating must not crack, peel, nor wipe off from the pattern surface [5–7].

EXPERIMENTAL

The parameters used in the EPC Method were as follows:

– type and density of evaporable patterns: polystyrene of 20 kg/m^3 density;
– type of tested alloy: $AlSi_{10}Mg$;
– casting temperature: 720°C;
– moulding sand: dry quartz sand of 0.3 mm grain size;
– assembling patterns for casting: "clusters" by assembling four plate shape moulds (20x50x200) mm onto the central runner gate (20x20x400) mm with (10x10x10) mm ingates;
– preparation of the liquid melt: refining and degassing by Na and K chloride salts, modification by Na;
– refractory coating type: based on talc, aqueous solution.

Before producing the refractory coating, the talc samples were tested by the following methods:

– X–ray diffraction, for phase determination and monitoring, carried out on a Philips PW 1710 diffractometer;
– qualitative mineralogical analysis, done on a polarizing microscope for reflected and transparent light, JENA POL–U, Carl Zeiss, Jena, with shape and grain size analysis.

Composition of the talc–based coating:

– refractory filler: talc of 42 μm grain size, 90 %;
– binder: bentonite 2.5 mass%, bindal H, 6.5–7 %;
– suspension stability agent: dextrin 0.3–0.5 %, Lucel 0.2–0.5 %;
– solvent: water.

Parameters of the pattern coating process (Figure 1):

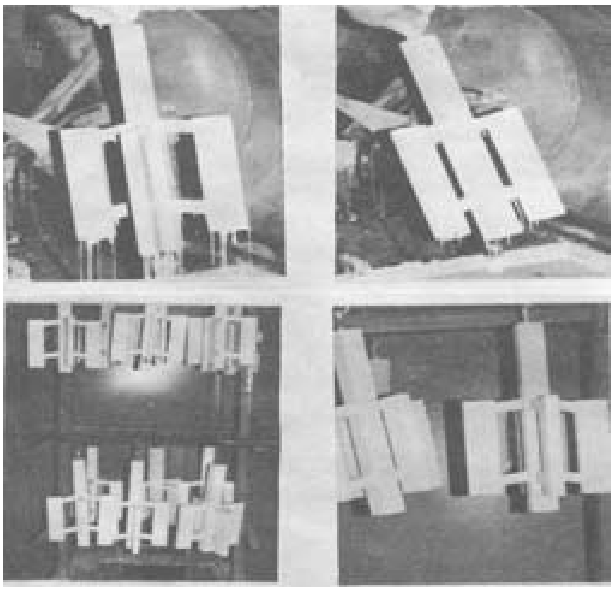

Figure 1. Pattern coating and drying

– suspension density: 2 g/cm^3;
– temperature: 22°C;
– slow suspension mixing during pattern coating;
– coating technique: immersion, pouring down, brush application;
– drying in air: the first coating – 1.5 h, finishing coating – 24 h;
– dry coating thickness: 0.1 mm.

The coated "clusters" were placed into a steel moulding box, covered with free sand using vibration, then the liquid metal was poured into the "full mould" (designation of the produced castings: T).

For realistic evaluation of the T castings, concurrent analyses were done with castings produced under the same conditions by casting into sand moulds (designation of the produced castings: S).

RESULTS AND DISCUSSION

The composition of the talc used for producing the refractory coating is shown in Table 1.

Table 1. Composition of talc for coating, %

Samples	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO
T	60.86	4.11	1.25	1.07	32.5

The X–ray diffraction of sample T is shown, where the dominant presence of talc can be seen in Figure 2.

Hystograms of the grain size and grain shape factor are shown. The average grain size of talc 42.87 μm, the minimum grain size was 10.77 μm, the maximum grain size 131.32 μm and the standard deviation σ = 20.51. The average grain shape factor was 0.59, which means that the grains were rounded in Figures 3 and 4.

The micrographs of sample T are shown in Figure 5. Tiny, irregular flakes of talc and chlorite, rather

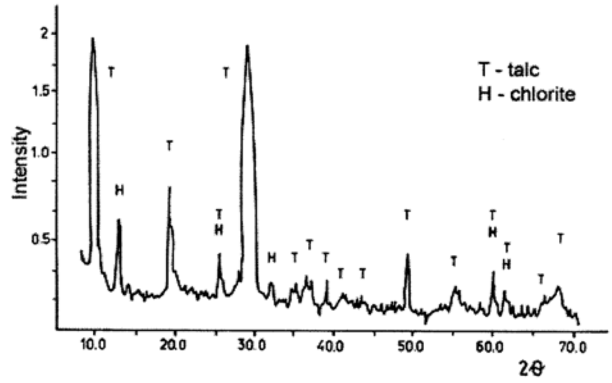

Figure 2. X–ray diffraction of suspension coating T

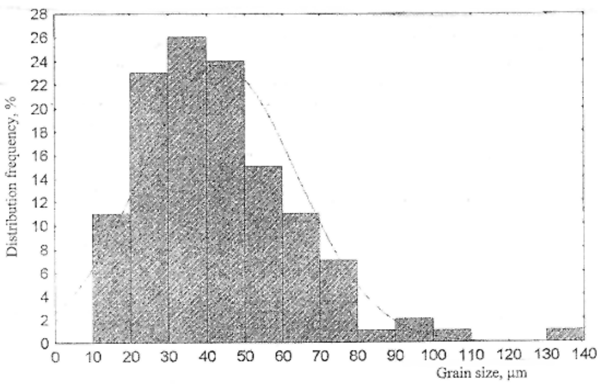

Figure 3. Hystogram of grain size, (T)

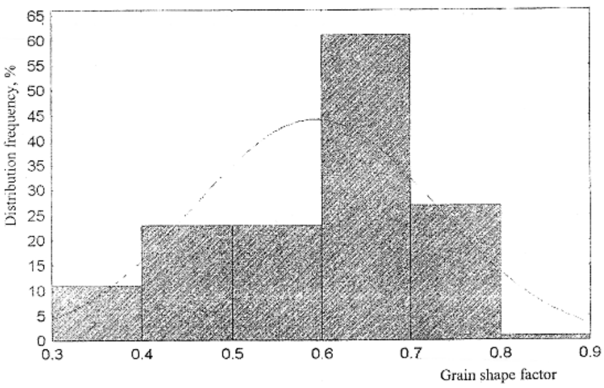

Figure 4. Hystogram of grain shape factor, (T)

homogeneously distributed in the solvent, can be seen. The distribution homogeneity of a refractory filler in the coating suspension depends on the suspension preparation and the method of application into the pattern. Steady, slow mixing of the suspension, keeping a steady density (2 g/cm^3) and temperature (22°C) are essential.

When testing coating T, applied to the pattern, it was found that it did not crack, nor peel. After casting, the coating was easily removed from the casting surface. The castings had a smooth and bright surface, without sintered sand or coating, so that cleaning was not necessary.

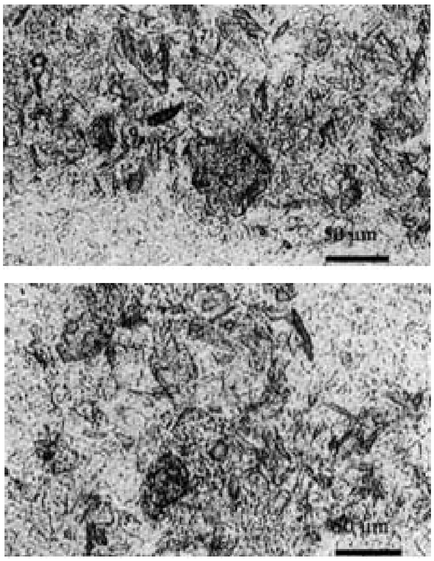

Figure 5. Micrographs of suspension of the sample T

Testing of the structural and mechanical properties of samples T and S showed that the results were within the limits of the standard for this type of alloy. It was found that samples S had a finer microstructure (Figure 6), which indicated the possible existence of a refractory coating insulation effect, which resulted in a mild increase of the crystal grains in the structure of castings T (Figure 7).

CONCLUSION

The application of a refractory coating, based on talc, with aqueous solution, in the Lost Foam process of silumine casting, showed positive effects. During application to a polystyrene pattern, the coating flows evenly, i.e. it is easily spread by a brush. The coating layers are of continuous thickness all over the pattern surface. It facilitates uniform solidification of the entire casting volume and rapid elimination of the pattern decomposition and evaporation products out of the mould during the pouring stage.

The actual importance of these problems is reflected in the fact that the application of quality coatings increases production efficiency by producing high quality castings, increased metal yield and eliminaties expensive casting operations–cleaning and machining.

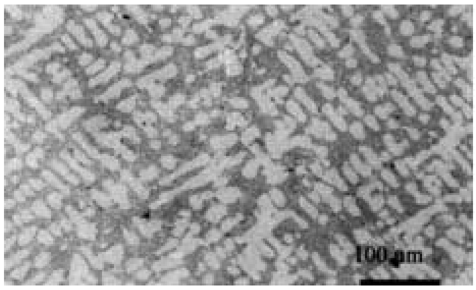

Figure 6. Microstructure of casting S

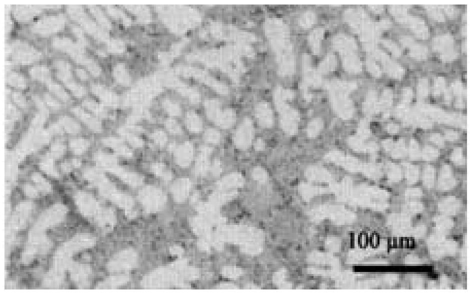

Figure 7. Microstructure of casting T

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