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Temat pracy: ***Ultrafine-grained materials based on Al-Si-RE alloys manufactured by rapid solidification***

Abstract:

Problems related to the manufacture by rapid solidification of lightweight aluminium alloys with an ultrafine-grained structure were described. The aim of the studies was to determine the effect of changes in the rapid solidification parameters and chemical composition of selected alloys with the addition of rare earth elements on the degree of microstructure refinement and mechanical properties.

The issues discussed in the study are important in the context of contemporary trends and growing interest in new, lightweight and high-strength materials based on aluminium alloys with ultra-fine grained structure, which can be used in many industries.

Based on the review of literature and preliminary analyses, near-eutectic Al-Si and Al-Si-Ni alloys with the addition of rare earth elements in the form of mischmetal were selected for studies. Mischmetal was chosen because it is a natural mixture of rare earth metals, thanks to which it is several times cheaper than pure rare earth elements.

Using melt spinning method with variable casting parameters, a series of melts with carefully selected, different concentration of alloying elements was produced. The stock in the form of ribbons was subjected to fragmentation and consolidation in plastic forming processes.

The microstructure and mechanical properties of the manufactured alloys, cast ribbons and extruded rods were characterized. An attempt was made to identify the components of the microstructure and classify their size. For this purpose, optical microscopy, scanning electron microscopy (SEM) with analysis of crystallographic orientation by electron backscatter diffraction (EBSD), transmission electron microscopy (TEM), X-ray phase analysis (XRD) and static tensile and compression tests were used.

The conducted tests and studies have shown that increasing the cooling rate (linear casting speed) during melt spinning significantly affected the refinement of microstructure in the cast ribbons. The addition of rare earth elements in the form of mischmetal as well as the addition of nickel refined the microstructure and produced numerous precipitates of fine intermetallic phases, thus improving the mechanical properties.

As part of the study, the mechanical properties of the manufactured materials were additionally characterized in the temperature range from 20°C to 500°C and it has been found that rods extruded from the ribbons retain their high mechanical properties also at elevated temperatures.

The studies contributed to obtaining the necessary knowledge on the design and production by means of rapid solidification of lightweight aluminium alloys with non-standard chemical composition characterized by ultrafine-grained structure.