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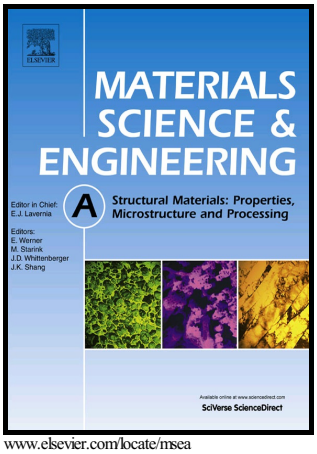

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Effects of high silicon contents on graphite morphology and room temperature mechanical properties of as-cast ferritic ductile cast irons. Part I – Microstructure.

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Abstract

Studying a series of near eutectic spheroidal graphite cast irons with various amounts of silicon up to 9.12 wt.% confirmed that: 1. silicon stabilizes ferrite to such an extent that ferrite is the Fe-rich phase appearing during solidification at the highest silicon contents; 2. silicon triggers graphite degeneracy such as chunky graphite. As well-known, cerium and magnesium do also increase the risk of chunky graphite formation while antimony counteracts cerium. Based on the metallographic observations of the present work, an index is proposed to evaluate the risk of chunky graphite appearance from the silicon, magnesium, cerium and antimony contents. Above a critical value of this index, the risk for chunky graphite formation increases steadily. Using data from previous studies, it is further demonstrated that the critical value decreases with increase in casting modulus as expected. The evolution of mechanical properties of the prepared cast irons will be presented in a second part of this study.

Introduction

Among fully ferritic ductile irons, three new grades EN-GJS-450-18, EN-GJS-500-14 and EN-GJS-600-10 have been recently introduced in the European Standard EN-1563:2012. These cast iron grades have been defined as "solution strengthened ferritic ductile irons" as they are alloyed with silicon contents in the range 3.2–4.3 wt.%. It has been reported that such high silicon contents promote high nodule count [1-3] and thus favor matrices with very high ferrite fractions. Such alloys have much higher strength than standard ferritic cast irons with comparatively low silicon contents though at the expense of lower ductility. On the other hand, the appearance of some graphite degeneration such as chunky graphite has also been related to high silicon contents in ductile irons [4-7]. As for the mechanical properties, an optimum silicon content of 4.3 wt.% has been reported on the basis of a limited number of alloys [8] which called for a more extensive study.

Accordingly, the present work reports results on 30 ductile cast irons with silicon contents ranging in between 2.29 and 6.14 wt.% cast in standard Y2 keel-blocks (EN-1563). For helping to understand some of the features observed in high silicon cast irons, an additional alloy at 9.12 wt.% silicon was also prepared and cast in similar conditions. The work is presented in two parts, this first one dealing with metallographic investigation and characterization of the alloys, the second part to come with their mechanical properties at room temperature. Metallographic observations showed graphite degeneracy in some of the castings which appeared worth of a detailed presentation and discussion in comparison to literature information and previous results.