Residual Stresses around Individual Graphite Nodules in Ductile Iron: Impact on the Tensile Mechanical Properties

Residual stresses in ferritic ductile iron castings have been studied for decades. However, little attention has traditionally been given to the local residual stresses which may arise in the microstructure as a result of the thermal contraction mismatch between the matrix and the graphite nodules during solid-state cooling. Recent synchrotron X-ray measurements performed by the authors have demonstrated that in the ferritic phase these local stresses can be in the order of 100-150 MPa, hence of the same order of magnitude as the material macroscopic yield stress. This suggests that they might have a significant influence on the mechanical properties of ductile iron components. However, no systematic research appears to have been conducted so far to investigate this aspect. The present work takes a first step in this direction by presenting an integrated theoretical analysis which addresses both the formation of these local residual stresses at the microscopic level and their role during mechanical loading at the macro-scale.

General information
Publication status: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
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Pages: 465-472
Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: Materials Science Forum
Volume: 925
ISSN (Print): 0255-5476
Ratings:
BFI (2018): BFI-level 1
Scopus rating (2018): CiteScore 0.33 SJR 0.173 SNIP 0.299
Original language: English
Electronic versions:
MSF.925.465.pdf
DOIs: 10.4028/www.scientific.net/MSF.925.465

Bibliographical note
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Source: FindIt
Source ID: 2436153214
Research output: Contribution to journal › Journal article – Annual report year: 2018 › Research › peer-review