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2 Introduction

3 Metallurgical processes have known a great evolution during the last 60 years. The advance-
4 ment is attributed to research disciplines, like physical metallurgy, which investigated a great
5 deal of solidification-related phenomena. Nowadays, metallurgists and physicists seek to un-
6 derstand deeper the connection between the different scales involved. From the nucleation
7 theory to the mechanical behavior of metals, an chain of intricate phenomena occur in a such
8 a way to create defects in the final product. This has been seen in casting processes like con-
9 tinuous casting and ingot casting. Surface and volume porosity, hot tearing and composition
10 heterogeneities are known defects to the casting community. As far as the current project is
11 concerned, the last defect, widely known as macrosegregation, is the subject of our interest.

12 Defects

13 Worth checking notes from the Ecole Thématique CNRS oléron (Check Mail Draft)

- 14 • Hot tearing
- 15 • Porosity
- 16 • Freckles
- 17 • Macrosegregation

18 Industrial Worries

19 Production

- 20 • Talk about total steel production, variations over the last few decades
- 21 • Quality constraints for many applications that require steel like construction, nuclear
22 engines ?
- 23 • Difficulties to meet these constraints and what are the present solutions

24 Research and Simulation

- 1 • Need for software handling multicomponent alloys

- 2 • Need for software handling finite diffusion in the solid
- 3 • Need for realistic alloy properties (not only constants)
- 4 • Need for handling moulds along with volume change (creating thermal resistances)

5 Worth discussing Isabelle Poitraud and David Cardinaux - and Claudine Allentin (respo comm Arcelor Dunkerque, search for mail)

6 **CCEMLCC contribution**

- 7 • some words about this ESA project
- 8 • in what ways does this project tries to alleviate the aforementioned problems ?
- 9 • academic and industrial partners and how does each of them contribute actually
- 1 • mention *Thercast* as the final developped code destination ?

2 **Chapter 1**

3 **Modelling Review**

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In this chapter the following points are discussed

- what does a typical solidifications problem consist of ? heat - fluid - solid - chemical species
- what are the modeling scales of these physics ? direct (micro: phase field / macro: CA) and indirect (micro Nancy models / macro: current FE model)

Maybe worth showing the 2x2 table that CAG showed at the ICASP conference ?

- Overview of these models ??
- Presence of AIR requires a new problem definition : Lagrangian or Eulerian framework

1.1 FE model

A section presenting the main FE equations that will be solved in the metal being a single domain.

- Energy (chapter 1)

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talking about Eulerian approach Air Metal will be presented in the next chapters

1.2 Biblio test

[1] are going to appear in the paper

2 Bibliography

- 3 [1] Tommy Carozzani, Charles-André Gandin, Hugues Dignonnet, Michel Bellet, Kader Zai-
4 dat, and Yves Fautrelle. Direct simulation of a solidification benchmark experiment.
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6 5623, 1543-1940. doi: 10.1007/s11661-012-1465-1. URL [http://link.springer.com/
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