11th World Congress on Structural and Multidisciplinary Optimisation
07th -12th, June 2015, Sydney Australia

Electromagnetic levitation coil design using gradient-based optimization

Suzanne Roberts[1], Schalk Kok[2], Johan Zietsman[3], Helen Inglis[4]

[1] University of Pretoria, Pretoria, South Africa, suzanne.elize.roberts@gmail.com;
[2] University of Pretoria, Pretoria, South Africa, schalk.kok@up.ac.za;
[3] University of Pretoria, Pretoria, South Africa, johan.zietsman@up.ac.za;
[4] University of Pretoria, Pretoria, South Africa, helen.inglis@up.ac.za;

Abstract

Electromagnetic levitation melting is a containerless technique to obtain material properties of reactive, electrically conductive materials that would otherwise result in sample contamination when in contact with a container at high temperatures. The levitation coil geometry, and the magnitude and frequency of the alternating current determine the sample sizes of a specific material that can be levitated as well as the temperature of the levitated sample.

The levitation cell is modelled using a one-dimensional analytical approach. This model requires the material properties of the sample and surrounding atmosphere as input variables. Since there is a large amount of uncertainty in measuring these properties they are regularized using experimental data from a known coil design and current.The levitation cell model with regularized material properties is then used in a gradient-based optimization scheme to design a coil for the levitation melting of specified sample size and material.

The consequences of using a multistart, gradient-based optimization scheme are reported. Coils are designed to minimize the temperature of the levitated sample or maximize the stability of the sample during levitation.

Keywords: gradient-based; multistart; electromagnetic levitation.