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Numerical solution of an inverse problem in nondestructive evaluation of materials

R. Celorrio[1], **E. Apiñaniz**[2], **A. Mendioroz**[2], **A. Salazar**[2]

ABSTRACT

Nondestructive evaluation of materials is a branch of material science concerned with the detection of material flaws and characterization of material properties, and usually leads to mathematical inverse and ill-posed problems [1].

In this talk we deal with the numerical solution of recovering a non homogeneous thermal conductivity profile, $k(x)$, from the response photothermal spectrum of an inspected material subject to periodical injections of thermal flows at frequencies $\omega \in [1, \infty]$. This kind of problems appear in the evaluation of hardened stainless steels [2], functionally graded materials [3] and cured dental resins.

The governing equation is $(k(x)\,u'(x))' + i\,\omega\,\rho\,c\,u = 0$ that becomes singularly perturbed for hight frequencies. Due to this character of the equation we use a non-uniform discretization of $k(x)$, the unknown of the inverse problem. Moreover the inverse problem needs to be stabilized by regularization techniques, because of its severe ill-posedness, and stated between proper Hilbert spaces, previously to be solve by nonlinear minimization techniques.

References

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[1]Departamento de Matemática Aplicada, EUITIZ/IUMA.
Universidad de Zaragoza.
Campus Río Ebro, Edificio Torres Quevedo, 50018 Zaragoza, Spain.
celorrio@unizar.es

[2]Departamento de Física Aplicada I, ETSI.
Universidad del País Vasco.
Alameda Urquijo s/n, 48013 Bilbao, Spain.
estibaliz.apinaniz@ehu.es, arantza.mendioroz@ehu.es,
agustin.salazar@ehu.es