Non-linear finite element modelling of light-to-heat energy conversion applied to nanoencapsulated phase change materials

Josep Forner-Escrig[*] [†], Rosa Mondragon[†] and Roberto Palma[†]

[*] [†] Department of Mechanical Engineering and Construction
Universitat Jaume I (UJI)
Av. de Vicent Sos Baynat, s/n 12071 Castelló de la Plana, Spain
e-mail: jforner@uji.es

ABSTRACT

In nature, physical phenomena tend to exhibit their effects simultaneously and, depending on the situation of study, their interactions cannot be neglected. This is the case of nanoencapsulated phase change materials (PCM), which are currently used for thermal energy storage in concentrated solar power plants [1]. For this reason, the light-to-heat energy conversion plays an important role on nanoencapsulated PCMs. On this ground, the aim of the present work is to develop a numerical formulation within the finite element method (FEM) [2] to study the light-to-heat energy conversion, phase-change and thermal stresses in PCMs. For this purpose, in a first and good approximation, it is assumed that the light is converted into heat by the Joule heating a non-linear term, which quadratically depends on the electric field. Therefore, the strong form is composed of a set of three coupled governing equations: balance of linear momentum for the mechanical field, balance of energy for the thermal field and balance of electric current for the electric field. These equations are rewritten in a weak form, which is more amenable in the context of the FEM, and they are implemented in a numerical code. Finally, several benchmarks are presented to validate the numerical results against analytical solutions developed by the authors.

REFERENCES

[1] N. Bozorgan and M. Shafahi, "Performance evaluation of nanofluids in solar energy: a review of the recent literature," *Micro and Nano Systems Letters*, vol. 3, p. 5, 2015.

[2] O. Zienkiewicz and R. Taylor, *The Finite Element Method 7th Edition.* Butterworth-Heinemann, 2013.