55th Annual Technical Meeting of the Society of Engineering Science (SES2018)
October 10 - 12, 2018, Leganés, Madrid, Spain

Overall thermal conductivity of fibre reinforced materials

Luca Lanzoni[1], Enrico Radi[2,*], Igor Sevostianov[3]

[1]DIEF - Università di Modena e Reggio Emilia, Via Vivarelli, 10- 41125 Modena, Italy.
e-mail: luca.lanzoni@unimo.it

[2]DISMI - Università di Modena e Reggio Emilia, Via Amendola, 2 - 42122 Reggio Emilia, Italy.
e-mail: enrico.radi@unimore.it

[3]NMSU – Department of Mechanical and Aerospace Engineering, New Mexico State University, Las Cruces, NM 88001, USA. e-mail: igor@nmsu.edu

The overall thermal conductivity of composites involving cylindrical fibres of irregular shape is investigated in the present work. Isotropic and homogeneous thermal conductivity is assumed for both the matrix and fibre. The system consists of an infinite plate with an embedded fibre subjected to a remotely applied steady state heat flux q^{∞} acting along a given direction. Once the alteration of the heat flux and temperature field T due to the presence of the inclusion is assessed, the homogeneized thermal properties of the composite material can be computed following the procedure reported in [1]. As an example, the dimensionless temperature distribution Tk/Rq^{∞} and heat flow $\boldsymbol{q}/q^{\infty}$ in an infinite with a non-conductive circula fiber is sketched in Figure 1, being k the thermal conductivity of the matrix and R denote the radius of the fiber.

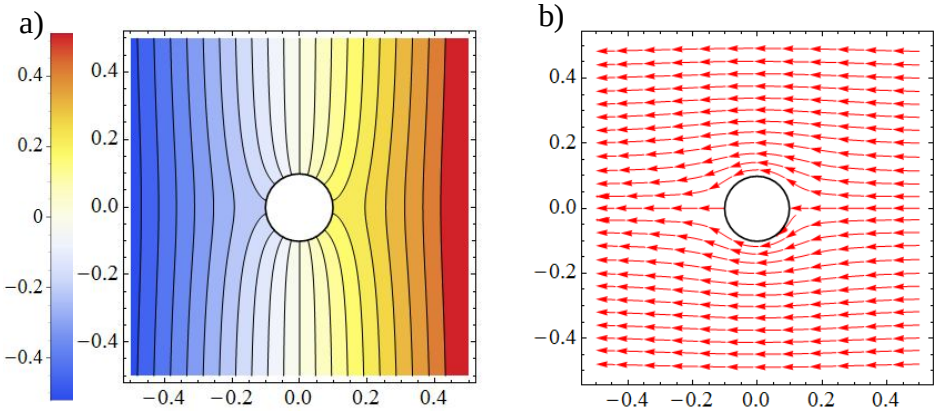

Figure 1: Distribution of the dimensionless temperature field (a) and (b) dimensionless heat flux in an infinite with an embedded circular fibre and subjected to a unitary steady state heat flow along the horizontal direction.

The study extends the results reported in [2] performed for non-conductive inclusions accounting for the real thermal conductivity of the fibres. The analysis allows assessing the effective thermal properties of a fibre reinforced material based on fibres with cross section formed by circular arcs, as polystyrene, polyacrylonitrile and sisal fibres.

References

[1] E. Radi, I. Sevostianov Proc. R. Soc. A, 472, (2016) 20150781.

[2] L. Lanzoni, E. Radi, I. Sevostianov Int J Solids Struct 138 (2018) 264-276