Modelling the Mechanics & Physics of Elastomeric Composites from the Bottom Up

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Course description: This short course will present state-of-the-art numerical and analytical methods to describe the macroscopic elastic and the viscoelastic response of elastomeric composites undergoing finite quasi-static deformations directly in terms of the mechanical behavior of their constituents and of their nano/micro-structures.

The course will begin by introducing a generic homogenization problem in the basic setting of finite elastostatics, together with (*i*) a numerical finite-element method, as well as with (*ii*) analytical iterative dilute homogenization methods and (*iii*) nonlinear comparison medium methods to generate solutions for such a problem. After their general description, these methods will be used to generate numerical and analytical solutions for three types of elastomeric composites of practical interest, to wit, elastomers filled with rigid inclusions, porous elastomers, and bicontinuous rubber blends. Comparisons between the (full-field) numerical solutions and the analytical solutions will be presented in order to illustrate the accuracy of the latter. The second part of the course will be devoted to generalizing the methods presented for finite elastostatics to finite viscoelastostatics.

Some useful references:

[1] Lopez-Pamies O, Goudarzi T, Nakamura T (2013) J Mech Phys Solids 61:1-18.
[2] Lopez-Pamies O, Goudarzi T, Danas K (2013) J Mech Phys Solids 61:19-37.
[3] Kumar A, Lopez-Pamies O (2016) Comptes Rendus Mecanique 344:102-112.
[4] Lefèvre V, Lopez-Pamies O (2017) J Mech Phys Solids 99:409-437.
[5] Shrimali B, Lefèvre V, Lopez-Pamies O (2019) J Mech Phys Solids 122:364-380.
[6] Leonard M, Wang N, Lopez-Pamies O, Nakamura T (2020) J Mech Phys Solids 122:364-380.
[7] Ghosh K, Shrimali B, Kumar A, Lopez-Pamies O (2021) J Mech Phys Solids 154:104544.
[8] Shrimali B, Ghosh K, Lopez-Pamies O (2021) Journal of Elasticity 153:479-508.
[9] Lefèvre V, Francfort GA, Lopez-Pamies O (2022) Journal of Elasticity 151:177-186.
[10] Shrimali B, Ghosh K, Lopez-Pamies O (2023) Journal of Elasticity 153:479-508.
[11] Sozio F, Lallet F, Perriot A, Lopez-Pamies O (2024) Int J Solids Struct 153:479-508.
[12] Lefèvre V, Sozio F, Lopez-Pamies O (2024) FE in Analysis & Design 232: 104114.