MSc project: Simulations of particle-laden tyre rubber

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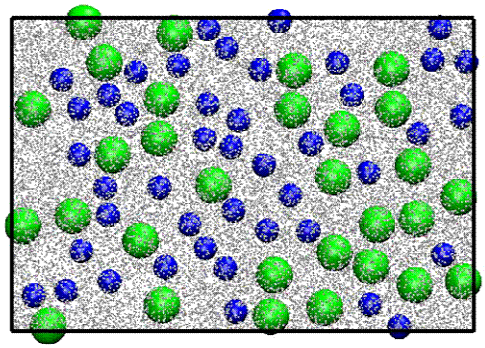
Partners: Apollo-Vredestein (Enschede) and Computational BioPhysics (TNW, UT)

Description of the project.

Application: The rubber in car tyres is a complex material, a polymer matrix containing dispersed and aggregated nano-particles [1-4], tuned for optimum driving properties. The flow properties of the initial mixture during the production stages of tyres, and the mechanical behaviour of the vulcanized rubber in tyres under driving conditions, are only partly understood. The design of tyre rubber, and hence tyres, with desired advanced properties is largely based on craftsmanship and extensive testing of selected rubber formulations.



Simulation snapshot of bidisperse colloids, with radii of 40 nm (blue) and 60 nm (green), in a 10% solution of polymers (grey).

Goal: Our objective is to develop and explore numerical models for the simulation of polymer matrices with embedded nano-particles. We are interested in the fluid pre-vulcanization polymeric melt encountered in the production process, as well as in the solid rubber of the end product.

Method: Our starting point will be a generic highly coarse-grained model for the simulation of visco-elastic materials, as recently developed in the Computational BioPhysics group (TNW, UT). This model will be extended to simulate high density colloid-laden polymer melts and cross-linked rubbers. Experimental data provided by Apollo-Vredestein will be used to validate the newly developed models.

Outlook: The successful development, implementation and analysis of a simulation model will improve our understanding of the mechanical behaviour of tyre rubber and of processing conditions toward producing tyres with improved performance.

Interested students are encouraged to contact Wouter den Otter at the above address.

Literature

[1] D.J. Kohls and G. Beaucage, *Rational design of reinforced rubber*, Curr. Opin. Solid State Mater. Sci. **6** 183 (2002).
[2] J. Fröhlich, W. Niedermeier and H.-D. Luginsland, *The effect of filler–filler and filler–elastomer interaction on rubber reinforcement*, Composites A 36, **449** (2005).
[3] T.R. Vijayaram, *A technical review on rubber*, Int. J. Design Manufact. Tech. 3 **25** (2009).
[4] K. Pal, R. Rajasekar, D.J. Kang, Z.X. Zhang, S.K. Pal, C.K. Das and J.K.Kim, *Effect of fillers on natural rubber/high styrene rubber blends with nano silica: morphology and wear*, Mater. Design 31, **677** (2010).