

3D Computed Tomography (CT) – How the power of Superman becomes reality

New method to investigate filler dispersion in rubber



Superman performing a CT scan in the pre-deep learning era

Reinforcing fillers are one of the main ingredients of rubber materials improving their mechanical properties and wear resistance. However, incorporation of the fillers into the rubber matrix can be a tricky task if the filler/rubber compatibility is not perfect. In practice reinforcing filler's particles form big clusters in rubber that deteriorate its performance. This can be avoided by developing a good mixing procedure. To achieve this an accurate examination of rubber after mixing is necessary to assess the filler dispersion. Recently, new techniques have surfaced that allow in-depth investigation of composites morphology, including porosity and fillers' dispersion. One of the novel techniques is computed tomography (CT) allowing 3D analysis of materials (Fig. 1) [1]. The aim of this project is to investigate the possibility to use CT for filler dispersion in rubber and compare it with other state-of-the-art techniques, like Scanning Electron Microscopy (SEM), Atomic Force Microscopy (AFM) or optical techniques.

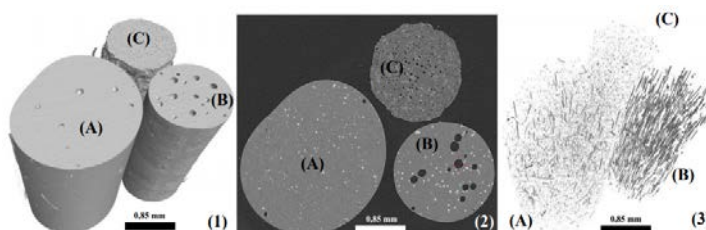


Fig. 1. CT scans showing (1) 3D structure and (2) cross-section 2D morphology of a polymer composite filament, (3) fillers dispersion in the polymer matrix inside the filaments [1].

Assignment

This project aims to develop a new approach to visualize and evaluate filler dispersion in rubber by means of 3D CT scanning technique.

State-of-the-art rubber samples filled with silica will be prepared by the student accordingly to current mixing standards. Afterwards, the silica dispersion will be investigated by 3D CT scanning and current 2D methods (optical and electron microscopy (Fig. 2)). The obtained results will be compared and discussed, with an emphasis on the potential improvement of dispersion testing methodology. By combination of the classic methods and CT scanning more insightful analysis is expected.

The practical work will be performed in the laboratories of ETE at the UT.

Report

The graduation report should be focused on the development of the new CT scanning method to evaluate the silica dispersion and compare it with current state-of-the-art methods.

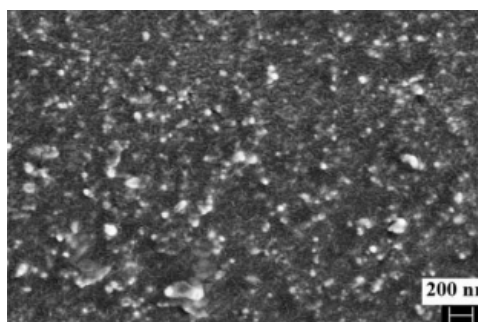


Fig. 2. Scanning electron microscopy picture of silica dispersion in CR/NR blend [2].

Start:

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References:

- [1] Ecker, J. V., Fürst, C., Unterweger, C., Plank, B., & Haider, A. (2017). Journal of Non-Destructive Testing.
- [2] Kappate, B. P., & Das, C. (2014). RSC Advances, 4(102), 58816-58825.