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Oral abstract

PDMS and MWCNT – How to Obtain an Efficient and Controlled Distribution of Conductive Fillers in PDMS

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Polydimethylsiloxane (PDMS) elastomers employing conductive fillers are used in many applications for e.g. flexible electrode materials or with lower amounts of fillers for high capacitance elastomers. Traditionally, the most used filler in these applications has been carbon black, which through high loading results in sufficiently high conductivities. During recent years, the range of conductive fillers has been extended to include i.e. expanded graphite, single walled carbon nanotubes and multi walled carbon nanotubes (MWCNT), whereof in particular MWCNT are interesting due to their outstanding electrical and mechanical properties. However, the use of MWCNT for many new applications requires efficient processing strategies in order to result in elastomers with an efficient dispersion of the nanomaterial. If it is possible to obtain an efficient dispersion of the nanomaterial in the PDMS precursors the mixture should additionally be able to crosslink without interference from the nanofiller[1]. There are several possible pathways to obtain such dispersions, where these could be divided into two main strategies, direct mixing using processing equipment or modification of the MWCNT followed by traditional preparation of the crosslinked elastomer. Both pathways have been investigated and the presentation will outline results from both approaches.

Direct processing of the MWCNT together with PDMS prepolymers by mechanical mixing, sonication, speedmixing or roll milling have been investigated. It is very clear that in order to obtain sufficiently effective dispersion, it is necessary to use the more efficient methods such as roll milling or speed mixing to distribute the fillers. Processing aids such as ionic liquids have been tested and found effective, though it requires higher amounts of additive or combinations with the most effective mixing methods and a thorough mixing in order to provide good dispersions.

As an alternative to direct mixing, modification of MWCNT is a well-known approach to ease dispersion of nanomaterials. This can be done by surface initiated polymerizations by e.g. atom transfer radical polymerization (ATRP) using compatibilizing monomers. Through the surface initiated polymerization a thin coating of polymer is introduced on the MWCNT to prevent agglomeration and permit much easier dispersion into the targeted polymer such as a PDMS prepolymer. Through simple methods of either entrapment or free radical grafting methods functionalized MWCNT (f-MWCNT) are prepared and applied in preparation of elastomers resulting in easy and efficient dispersion of the nanofillers in the elastomer. In addition to this, the choice of method permits preparation of composites with either well distributed fillers or entrapped fillers providing access to high capacitance composites with an artificially high percolation threshold[2] or to obtain conductive elastomers with a MWCNT loading of 5 wt% only.

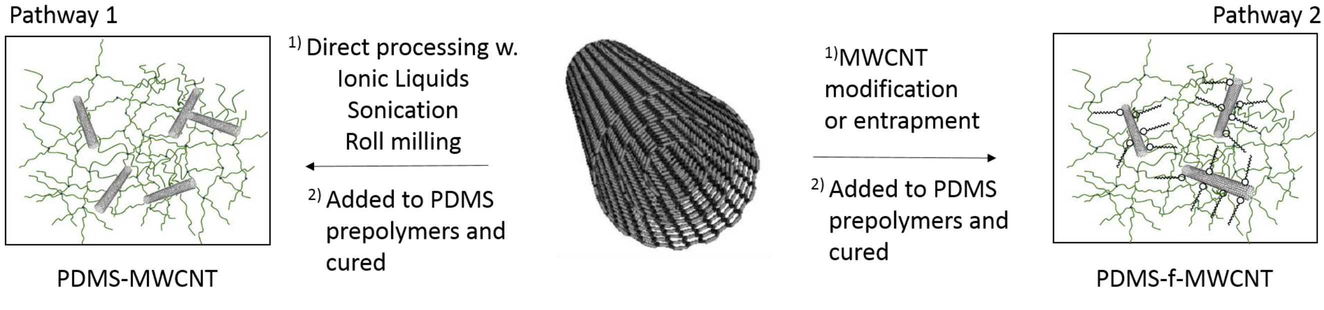

Figure 1: Dispersing MWCNT effectively in PDMS by Pathway 1 - Direct processing or Pathway 2 - Modification or entrapment and subsequent crosslinking.

[1]. S.S. Hassouneh, A.E. Daugaard, A.L. Skov, Design of Elastomer Structure to Facilitate Incorporation of Expanded Graphite in Silicones without Compromising Mechanical Integrity; Macromolecular Materials and Engineering, 2015.

[2] K. Goswami; A.E. Daugaard, A.L. Skov; Dielectric properties of ultraviolet cured poly(dimethyl siloxane) sub-percolative composites containing percolative amounts of multi-walled carbon nanotubes, RSC Advances 2015.