Chemical reduced graphene in polymer fibers - a novel route to mobile charge storage devices?

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I. Introduction

Since graphene was fabricated successfully for the first time by Geim and Novoselov, the research interests on graphen have increased enormously. The physical properties of this two-dimensional carbon variation offer multiple, potential applications in future. Due to the graphen's high mobility and charge carrier density, graphen is qualified as potenzial material for charge storage devices and supercapacitors. At Institut für Textiltechnik (ITA), RWTH Aachen University, Germany, novel grapheme polymer supercapacitors are in the focus of research. Chemically reduced grapheme is spinned in polymer fibers at temperatures above 200 °C by using an extruder. Afterwards, the fibers can be continue processed which offers an application as fiber battery in clothing, for example. In the following abstract, the chemical fabrication of grapheme is described as well as the spinning of polymer fibers. Additionally, an overview of possible future applications is given.

II. Fabrication of graphene

The chemical reduction of graphite oxid is a simple und cheap possiblity for fabrication of graphene. Graphite oxide is given in a suspension with destillied water and is then sonicated. As a consequence, the graphite oxide layers get exfoliated to graphene oxide. The suspension is then heated to a temperature range between 50 °C and 90 °C. High concentrated sodium or potassium hydroxide solution is given to the suspension which enables a reduction of the functional groups in graphene oxide. After that, the suspension is cooled down to room temperature and centrifugalized in order to separate the graphene from the suspension. The resulting graphene gets washed with destilled water and finally freeze-dried.

III. Spinning into polymer fibers

By using a DSM mini extruder, the graphene layers are spinned into a polymer at temperatures above 200 °C. The forced control spinning guarantees a consistent allocation of the graphene into the polymer. Polypropylene is a promising polymer for fabrication of mobile charge devices, because the molecular structure is very linear and thus a high degree of crystallinity is reached. The high linearity enables a homogenous allocation of graphene in the polypropylene fiber. Furthermore, polypropylene is available at industrial scales and not dangerous to human and environment. Polypropylene offers a high mechanical stability which makes it applicable for applications with highest requirements.

IV. Applications and summary

The research at Institut für Textiltechnik (ITA) pursues the goal to make polymers and polymer composites applicable for different applications at industrial standards. Beside the development of fiber reinforced plastics and other applications, the development of charge storage devices came into the focus of research at ITA. Graphene polymer composites offer themselves for aftertreatments, with the

consequence that an application as textile battery in clothing is a realistic scenario. The polymer fibers exhibit a low cross-section and a high flexibility which enables a simple bunching of the fibers. Thus, cheap and high performance charge storage devices in form of polymer fiber clusters for industrial and research applications.

In summary, it can be stated that research activites on application of graphene-polymer fiber composites offers an enormous potential which has to be utilized. The versatile applications could solve existing problems in energy storage. Thus, the electrical power supply of the human population could be granted independent from weather conditions like wind or sun. The costs of energy storage systems could be reduced enormously. On the other side, textile batteries in clothing would offer many applications, for example mobile monitoring systems of bodily functions. Perilous complications like apoplectic strokes or cardiac infarction could be treated faster because the arrival time of an emergency physician would drop if the monitory system is connected to a rescue centre.

These examples only show a little part of potential application fields, because a complete listing of the applications would blast this abstract. The intention is to show the enormous potential of research activities on graphene charge storage devices. It is worthwile to intensify and support this research.

References

[1] Fan X et al. Advanced Materials, 2008, 20, 4490-4493. doi:10.1002