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Multifunctional nanomaterials for advanced structural, sensing and energy storage applications

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In our research we have mainly focused towards the synthesis and modification of different types of nanofillers for their applications in sensors, fuel cells, energy storage devices and polymer/metal matrix composites for aerospace and structural applications. We have synthesized graphene oxide via different methods i.e. HNO_3 introduced improved Hummers method (Figure 1) and risk husk process (Figure 2).

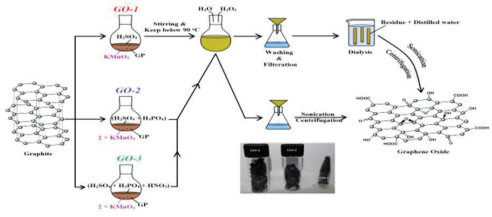

Figure 1: Procedure for synthesis of graphene oxide [1]

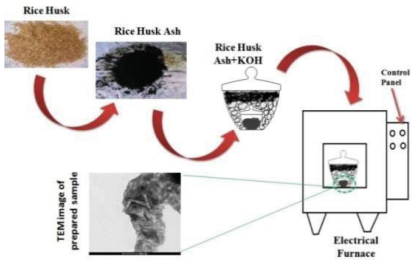

Figure 2: Preparation of graphene from rice husk ash

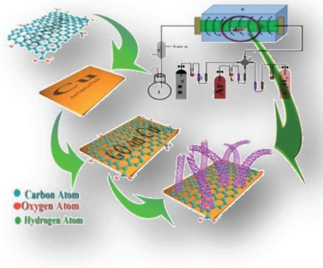

Figure 3: Growth of carbon nanotubes (CNTs) using graphene oxide as catalyst

The use of this graphene oxide for gas sensors and energy storage devices such as supercapacitor electrodes, proton exchange membrane and fuel cell has been carried out. Moreover, a new approach has been tried to use this graphene oxide as catalyst for the growth of CNTs via thermal CVD technique, as shown in Figure 3. Beyond the use of graphene based fillers in preparing composites for electronic applications, the use of carbon black, nanoclay, CNTs and rGO as reinforcement for preparation of polymer composites has been studied to observe the effects of these fillers towards mechanical properties of polymer composites.

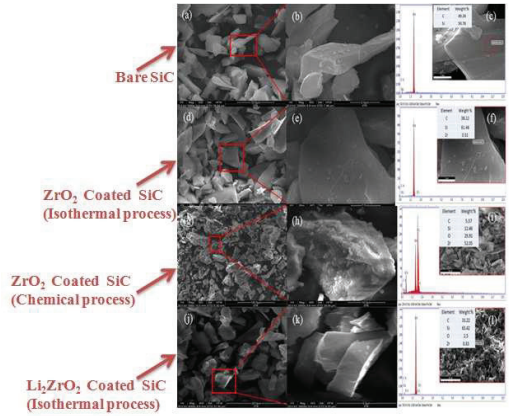

Figure 4: FE-SEM micrographs: ZrO_2 and LZO coating layer on SiC [2]

Modifications of carbon black, CNTs and SiC have been carried out to observe the effect of surface modified fillers in polymer and metal matrices. Also, in-depth studies of metal matrix nanocomposites after the grain refinement by SPD (Severe Plastic Deformation) through FSP (Friction Stir Processing) process have been done successfully.

References

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2. S. Singh, K. Pal, Mater. Des. 82 (2015) 223.