The significance of vacuum treatment prior to the curing of PDMS (SYLGARD 184)/CNTs nanocomposite

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***Abstract*—A never reported effect as a result of omitting vacuum treatment during fabrication of PDMS/CNTs nanocomposite is reported. EDS and FESEM results indicate the presence of voids and NaCl crystals on the surface of nanocomposite. The results indicate the importance of vacuum treatment prior to the curing of nanocomposite.**

***Keywords*—Sylgard 184, PDMS, NaCl, Vacuum treatment, CNTs, Nanocomposite**

I. INTRODUCTION

PDMS/CNTs nanocomposite is attracting a lot of attention as a result of their numerous applications in flexible electronics[1], haptic devices[2] and organic electronics[3]. Several research groups have been trying to optimize the process of fabricating such nanocomposites to reduce the amount of CNTs in PDMS[4]; for homogeneous dispersion of CNTs in PDMS and to commercialize the fabrication process for further applications and studies. There are few reports of homogenous dispersion of functional CNTs in modified PDMS[5], [6] though; these techniques, processes and materials are costly and inefficient for commercial applications.

There are several vital steps to fabricate PDMS/CNTs nanocomposite that have been argued and studied, such as functionalization of CNTs[7], plasma treatment of PDMS[8] and curing time and temprature[9], nonetheless there is not a single report to magnify the importance of vacuum treatment prior to the curing of nanocomposite. Although many groups reported to have carried out this step to avoid the formation of air bubbles that could cause voids in nanocomposite, herein a previously never reported outcome in addition to formation of voids is reported, that may happen as a result of omitting vacuum treatment step.

II. MATERIALS AND METHODS

A. *Materials*

Commercial multiwall carbon nanotubes (MWCNTs) produced by catalytic decomposition (L.MWNTs-2040, length=5-15μm, diameter=20-40nm, Shenzhen Nano-technologies Port Co. Ltd., Shenzhen, China); Polydimethylsiloxane (PDMS) (SYLGARD 184); THF (Sigma Aldrich); All chemicals were used as received without further purification.

B. *Methodology*

PDMS/CNTs nanocomposite was prepared using solvent mixing. The CNTs were mixed with THF (0.1mg/ml) through ultrasonication for one hour. PDMS base was mixed with THF (100mg/ml) in a separate beaker for 30 minutes. The two mixtures were then mixed together via magnetic stirring on a hotplate at 80°C to remove THF; the sample was ultrasonically mixed after every 30 minutes of stirring. After evaporation of the solvent, curing agent was added to the mixture and vigorously stirred for 10 minutes. The final product was then molded. The fabricated nanocomposite was then placed in oven at 150°C for 15 minutes until the nanocomposite fully dried.

C. *Characterizations*

The fabricated nanocomposite was subjected to FESEM (Fei Nova Nanosem 230) imaging and EDS (Fei Nova Nanosem EDS) analysis.

III. RESULTS AND DISCUSSION

A. *FESEM Imaging*

By looking at the fabricated nanocomposite via naked eyes an unsmooth and uneven surface was easily noticeable. Fig. 1 displays the obtained FESEM image of the fabricated nanocomposite in which the voids generated as a result of omitting vacuum treatment prior to curing are clearly demonstrated. Omitting vacuum treatment results in presence of air bubbles within nanocomposite that produced voids after curing.

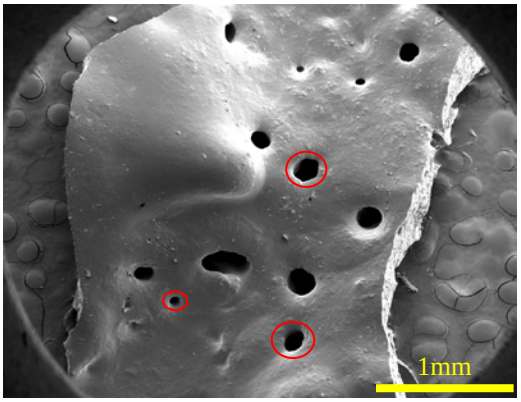

Fig.1 FESEM image of PDMS/CNTs nanocomposite indicating the presence of voids

B. EDS Analyses

Fig. 2 shows the EDS results of fabricated nanocomposite. The presence of cubic crystal structures were noticed all over the nanocomposite which were subjected to EDS analysis. The result indicates the presence of NaCl on the surface of fabricated material. This may be due to the presence of Pt catalyst present in the curing agent of sylgard 184 PDMS.

It is well known that cross linking of sylgard 184 PDMS is due to hydrosilylation which is a catalytic process in which molecules of base and curing agent bond to produce the final solid product. There are several types of available Pt catalyst however; the presence of NaCl indicates the presence of Sodium hexachloroplatinate (Na_2PtCl_6) as the catalyst in the curing agent.

Based on this result it could be said that during vacuum treatment the chlorine atoms are removed from the sample and sodium atoms are sedimented. By neglecting the vacuum treatment these atoms remain in the sample and bond during curing process which result in presence of NaCl in the sample.

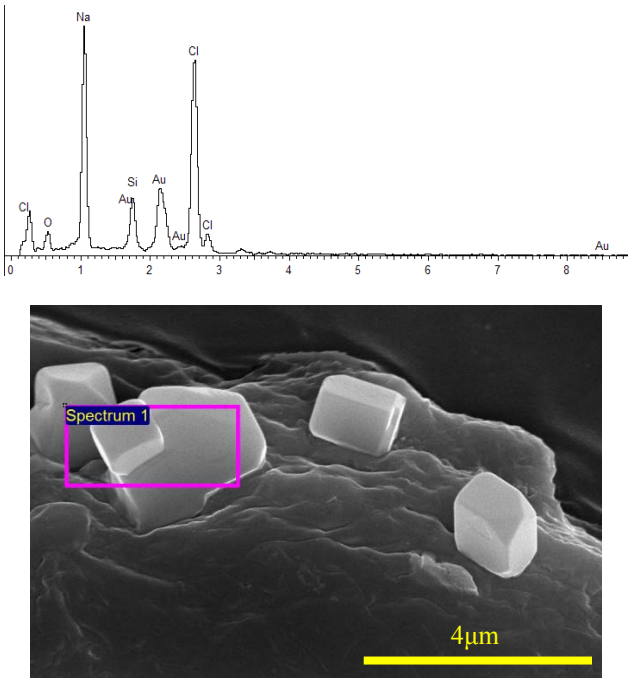

Fig. 2 EDS results of fabricated nanocomposite indicating the presence of NaCl crystals

IV. CONCLUSIONS

These results indicate that to avoid having voids in the sample which is considered as defects and could result in difficulties and errors in physical, chemical, thermal, electrical, optical and mechanical measurements, vacuum treatment prior to curing process is necessary. On the other hand it is clear that while using sylgard 184, vacuum treatment is an important step in which the residue elements present in curing agent are removed. The presence of NaCl crystals confirms this suggestion.

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