Effect of liquid Nitrogen aging time on the ILSS properties of Carbon fiber/Epoxy composite decorated with Graphene-based nanofillers

Satyaroop Patnaik[1], Pavan Kumar Gangineni[1], Bankim Chandra Ray[1], Rajesh Kumar Prusty[1]

[1]FRP Composite Laboratory, Department of Metallurgical and Material Engineering, National Institute of Technology, Rourkela 769008, India

Abstract

Carbon fiber reinforced polymer (CFRP) composites are used as materials in many applications. In his work carbon fiber (CF) surface is grafted with GO and GOH via electrophoretic deposition. Laminates were cryo-conditioned in liquid nitrogen for different times. The effect of fiber modification becomes less prominent with increasing time of cryo conditioning. GO was better than GOH as a nanofiller. Thermal shock and development of internal stresses was observed in 1 hr of aging. Recovery of values at higher conditioning times was observed. Scanning electron microscopy, to identify various modes of failure, was carried out

1. Introduction

Carbon fiber reinforced polymer (CFRP) composites are extensively being used as materials in aerospace and aircraft applications. For cryogenic storage tanks mostly used in rockets, which require materials having high dimensional stability and low thermal conductivity, CFRP composites are an exquisite alternative to metals due to their lightweight. These materials have to sustain and retain their promising mechanical properties which include high strength to weight ratio and stiffness at extremely low temperatures. Modifying matrix and fiber surface of FRP composites with nanofillers has shown improved mechanical properties at both room temperature (RT) and cryogenic temperatures (CT). Fiber surface modification yielded better results when compared with modifying polymer matrix at both RT and CT [1]. Modification of fiber surface by electrophoretic deposition (EPD) of graphene-based nanofillers promises better properties at RT [2]. Graphene oxide (GO) and Graphene hydroxyl (GOH) have proved to be the better nanofillers in fiber modified CFRP composites at CT and RT [2,3]. CT behavior of FRP composites shows an interesting trend with aging time in matrix modification[4], but there is a dearth of literature stating the results of fiber modification at different cryo-aging times. This work involves the

decoration of carbon fiber (CF) surface of carbon fiber epoxy (CF/E) composites with two types of Graphene-based nanofillers.

2. Experimental details

GO and GOH were implemented onto the CF by EPD technique. The parameters of EPD were kept the same for both the nanofillers (5A, 1g/L, 30 min). A comparative study of the effect of aging time (1 hr, 3 hrs, 6 hrs) in liquid nitrogen on the ILSS properties of 3 CFRP composites (Neat, GO-CF/E, GOH-CF/E) was done. SEM micrographs supporting the explanation were studied.

3. Results and discussions

A dip in ILSS at 1 hr of aging and recovery at higher times of aging can be seen in Fig. 1(a) which may be attributed to thermal shock and development of internal stresses. Recovery at higher times of aging may be due to attainment of steady-state. GO shows the best properties at 0,1,3 and 6 hrs of aging. Fig. 1(b) shows 6 hrs of aging showcasing a drastic increase in ILSS of Neat (13.74%), GOH-CF/E (11.87%) and GO-CF/E (16.56%) compared to 1 hr aged Neat, with the highest increase in GO-CF/E. Therefore, 1 hr aging in liquid nitrogen led to a decrease in ILSS properties due to thermal shock. ILSS properties recovered with longer aging times. Fiber modification using GO and GOH as nanofillers via EPD is a successful process for increasing cryo-ILSS properties of CFRP composites.

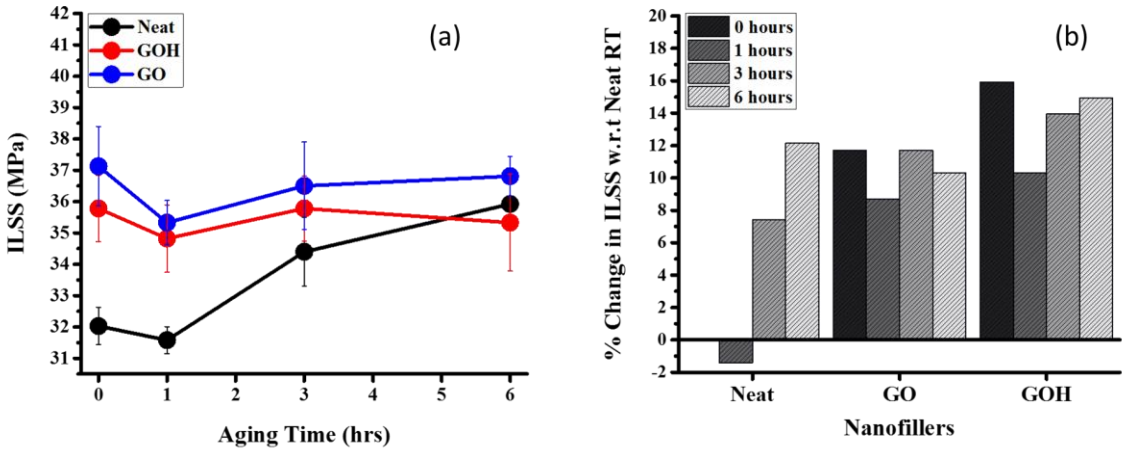

Fig. 1 : (a) ILSS vs aging time (b) Change percent in nanofillers at different aging times.

4. Conclusions

- Fiber modification by GO when comopared to GOH nanofiller
- 1 hr conditioning induces thermal shock and dip in ILSS values
- Recovery occurs at higher times of conditioning

References

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