PREFACE

Ceramic based composites are extensively being used in the applications where aggressive environments are involved. These composites are replacing other materials in several applications where performance in aggressive environment is more important than the cost. The tribological response of ceramic fibre reinforced ceramic matrix composites is an important topic. Carbon fibre reinforced carbon matrix (C/C) composites are the first representatives of ceramic fibre reinforced ceramic matrix composites. Carbon fibre reinforced phenolic resin (CFRP) composite is basically used to convert CFRP composites into C/C composites via graphitization method at 900 ^{o}C. C/C composites were initially developed for aerospace applications but now they are also being used in nuclear reactors, biomedical implants and automobiles. C/C composites are standard materials for the brake disks of racing cars and aircrafts. As brake disks, their performance depends upon several factors such as normal load, sliding velocity, formation of friction layer/film, and service environment. C/C composites have to pass through several environments when used as brake disks of aircrafts and high speed cars. The tribological behaviour of C/C composites is very much dependent on the surrounding environment. The extent of gases and water vapour present in the surrounding environment depicts the tribological performance of C/C composites. Thus its tribological behaviour is unstable. Further the oxidation resistance of C/C composite is also low which limits its service lifetime.

Carbon fibre reinforced carbon/silicon carbide (C/C-SiC) dual matrix composites were firstly developed by liquid siliconization infiltration (LSI) method for applications in aggressive environments.. Silicon carbide has high oxidation resistance, superior thermal stability and high creep resistance. The tribological behaviour of C/C-SiC composites is also stable. But the density of C/C-SiC composites is higher as compared to C/C composites. This makes it less desirable in weight sensitive applications.

The tribological behaviour of fibre reinforced composites varies with the orientation of fibres with respect to the sliding direction of counterface because area proportion of different constituents change with the orientation of fibres. This change in area proportion may lead to several other tribological mechanisms when the composites are slid against a counterface material. Most of the investigations in the area of tribological behaviour of C/C and C/C-SiC composites dealt with the parallel orientation of laminates. The conformity of interacting surfaces also effects the tribological behaviour. C/C and C/C-SiC composites are mostly investigated with fully conformal surfaces. Further, normal load and sliding velocity also affect the tribological behaviour of composites. The mechanism and inset of friction film formation and disruption in C/C and C/C-SiC composites depend upon the normal load and sliding velocity. Surrounding environment also affects the inset of friction film formation and disruption. For example, the presence of water vapour in the surrounding may lead to easy shearing of layers of graphite in C/C composites and form friction film whereas its absence makes the shearing of layers difficult and may lead to dusting regime. Thus environment has significant impact on the tribological response of C/C and C/C-SiC composites.

In the light of above, present investigations were carried out to study the tribological behaviour of C/C and C/C-SiC composites under different environments. Dry, brake oil and freezing environments were chosen to investigate the tribological behaviour. The reasons to choose these three environments are written in the chapters related to respective environments. It was observed that friction film formation was difficult in brake oil environment due to mixing of wear debris with brake oil. An oxide layer was observed in freezing environment which was absent in dry and brake oil environments. Laminate orientation and surface conformity were also varied. Parallel and normal orientation of laminates were considered along with low conformity and non-conformal hertzian contacts. Composites were tested for unidirectional and reciprocating sliding conditions. Normal load and sliding velocity were varied when the composites were tested in unidirectional sliding and only normal load was varied when composites were tested in reciprocating sliding. In the last, reciprocating sliding behaviour of C/C and C/C-SiC composites was investigated in self and complementary mated pairs.