Review on Mechanical property Modification technique of Polyetheretherketone (PEEK) Composites

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Abstract- Polyetheretherketone (PEEK) is one of the popular thermoplastic polymer due to its mechanical properties. The durability is very high under high temperature condition. Various modification have been done in PEEK matrix by incorporating different ceramics like SiC,SiO_2, AlN, Zirconia, hydroxyapatite (HA), Al_2O_3, addition of fibers like glass, carbon fibers, PTFE and its effects in the properties have been studied. Properties changes are made in the PEEK to increase its utility in tribological field and application in medical. This review summarizes the effect of the inclusion of the various materials and its effect on hardness, wear rate, tensile strength of PEEK.

Keywords---Polyetheretherketone, modifications, mechanical Properties

I. INTRODUCTION

POLYETHERETHERKETONE is a semi crystalline thermoplastics having a melting point (T_m=335°C) and glass transition temperature (T_g=143°C). PEEK has found its applications in aerospace industries, manufacturing industries due to its resistance to chemical, showing stability at very high temperatures, toughness [1]. The Coefficient of friction of this material is around 0.7 which is very high for its use as an anti-friction. Various types of modifications has been done in order to change the mechanical properties of PEEK, to increase its performance in different condition like high load, dry condition, lubricating. In this review paper addition of different reinforcements of fiber, mixing of nano/micro particles in the PEEK and its effects in the properties of PEEK has been discussed.

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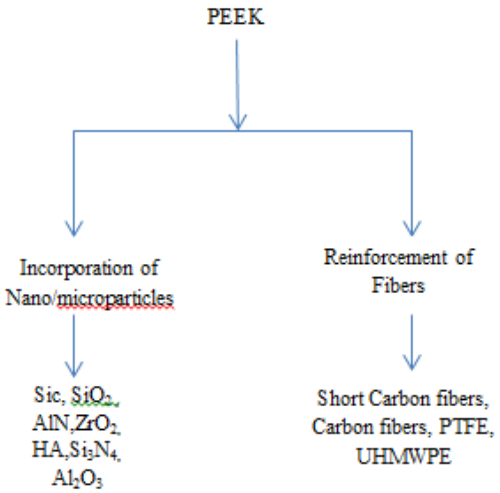

II. MODIFICATION TECHNIQUE

PEEK has been modified using following techniques, (a) Reinforcement of fiber & (b) mixing of micro/nano particles. It has been seen that incorporation of particulate is easier then reinforcing fibers into the PEEK. The PEEK powders are mixed with nano/micro particles in an alcohol medium then dried and sintered [2].

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III. DISCUSSIONS

When PEEK composites are formed with SiC, it is found that coefficient of friction reduces and even the wear rate decreases for certain ratio of mixing between 7.5 wt.% to 10 wt. %. SiC fillers are found to efficient in decreasing the wear rate [3]. Inclusion of nano size Silica in the PEEK showed the increase in the hardness than that of unfilled PEEK. The increase in the wt. % of the silica showed the reduction in the elongation property of the PEEK and reduction in strength due to pre matured failure. Degree of crystallinity can be increased by addition of silica in limited amount [4,5]. Mixing of AlN in micro size and nano size ceramic particles leads to the increase in the micro hardness. It was also seen that hardness is greater for nano composites than micro composites due lesser distance between in the nano particles [6]. Higher thermal stability was observed by Thermo

gravimetric analysis (TGA) of Zircornia PEEK composites at high temperature as compared to the unfilled PEEK. Zirconia did not affect the glass transition temperature but the hardness, tensile strength, tensile and flexural modulus showed an increase [7]. HA-PEEK composite shows exponential increase in the Young's modulus. Tensile strength of the HA-PEEK decreases after the wt.% is higher than 10 in a linear way. The tensile strength of HA-PEEK composite is near to cortical bone and even the strain to values is similar to cortical bone. The results have enhanced the research in the field of HA-PEEK bio-composite [8]. Composite of PEEK and Si_3N_4has also shown the similar changes in the mechanical properties. Increasing the amount of Si_3N_4 in the PEEK leads to the linear increment in the hardness, compressive strength and bending strength but it shows reduction above 1.25% weight. Coefficient of friction reduces up to the 7.5 wt. % then tends to increase [9]. PEEK-Al_2O_3composites micro hardness and stiffness rises with the rise in the content of Al_2O_3. Friction coefficient was found higher than unfilled PEEK. Wear resistance reduces above 3.5 vol% of Al_2O_3 [10]. PEEK reinforced with Short carbon fiber has shown a significant increase in tensile strength, if the mass fraction is greater than 10% the rate of increase of tensile strength reduces. SCF reinforcement increases the thermal expansion of the composite [11]. Incorporation of carbon fiber reduces ductility and improves wear resistance [12]. When CF was added In the PEEK matrix the machinability of composite decreased as compared to the pure PEEK. Mechanical properties are not uniform for CF/PEEK it totally depends on the distribution of carbon fiber in the PEEK matrix [13, 14]. Polytetrafluroethylene addition in the PEEK has showed its improvement in the performance. A high improvement was seen in both wear and frictional coefficient. Only increase was seen in the case of Impact Strength rest all the strength and modulus decreased with increase amount of PTFE in the PEEK [15]. The inclusion of the glass fiber in the PEEK increased the tensile strength, tensile modulus, flexural modulus of the composite compared to the unfilled pure PEEK and the wear resistance against the sliding material [16]. PEEK when filled with inorganic materials like SCF, TiO_2, ZnS, Graphite, SiO_2 leads to moderate increase in the crystalline structure of the composites, matrix hardness, stiffness and little increase in the tensile strength. Mechanical properties depend on the fiber orientation in the matrix [17]. It was found that frictional coefficient and specific wear are higher for dry condition than for water lubricated condition. Transferred films were removed due to the lubrications [18]. PEEK wear rates depends on the temperature condition on the operation is performed [19].

IV. Conclusion

Reinforcement of the various material may one way to enhance the mechanical property of PEEK. The structural change may the other process to produce the satisfied mechanical behavior. So selection of proper composition and correct structured material is a very important factor of the PEEK composite to produce prominent results.

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