On the sliding behavior of PAEK composites in vacuum environment

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Abstract
The tribological behavior of PEEK and PEKK composites were investigated in air and vacuum environment. Polymers were filled with either glass (GF) or carbon (CF) fibers and compared with standard materials containing 10% CF, 10% Graphite (Gr) and 10% PTFE. In vacuum, the tribological performance of these compounds depends on material compositions, fiber orientation as well as test conditions. Very low friction and wear coefficient were obtained at low sliding speed while severe wear occurred at high speed. In particular, excessive wear debris of CF filled composites led to ignition after opening the vacuum chamber.

Materials

<table>
<thead>
<tr>
<th>Name</th>
<th>Fillers</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEEK</td>
<td>-</td>
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<tr>
<td>PEEK30GF</td>
<td>30% CF</td>
</tr>
<tr>
<td>PEEK30CF</td>
<td>30% CF</td>
</tr>
<tr>
<td>PEEKCFGr</td>
<td>10% CF, 10% PTFE, 10% Graphite</td>
</tr>
<tr>
<td>PEKK</td>
<td>-</td>
</tr>
<tr>
<td>PEKK30CF</td>
<td>30% CF</td>
</tr>
<tr>
<td>PEKKCFGr</td>
<td>10% CF, 10% PTFE, 10% Graphite</td>
</tr>
</tbody>
</table>

Results

Friction and wear rate of PEEK and PEKK materials at 0.2 m/s:
lower friction in vacuum; severe wear for PEKKCF in vacuum

Friction and wear of PEEK and PEKK materials at 1 m/s:
severe wear rate and failure at 1 m/s in vacuum

Friction behavior of PEEK and PEKK at 1 m/s:
PEKK is more stable than PEEK in vacuum

Raman spectra of PEEKCF indicate higher degree of graphitization in vacuum

Experiments
pin-on-disk (52100 steel, Rz = 0.05 μm)
continuous sliding
duration: 24 hrs
sliding velocity: 0.2 m/s or 1 m/s
contact pressure: 2 MPa
air (40% r.h.), vacuum 10^-5 mbar

Optical microscopy images of the steel disks running at 0.2 m/s against
a) PEEK, b) PEKK, c) PEEKCF and
Self ignition of wear debris after opening the vacuum chamber

d) PEKKCF

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