1. 2 Effect of Molding Conditions and Irradiation on Polymeric Wear:

Wear of polymeric materials used in implants is perhaps the most difficult to understand .As a result, numerous reports on polymeric wear have emerged over the years . In biomedical applications such as occluders in mechanical heart valves and joint prostheses, fatigue fracture and wear of the polymers have been considered to be an important factor in determining the durability of the prostheses. In the case of UHMWPE, many factors influence its wear properties. For example, when UHMWPE was molded between 190 and 200°C and some antioxidants were added during processing, its wear resistance appeared to improve. Molding at higher pressures and increasing the molecular weight, on the other hand, were reported to be detrimental. Nonetheless, there is a possibility that there could be an optimum processing condition and molecular weight distribution that could give the best wear characteristics. More recent work has shown that processing conditions play a vital role on the cyclic fatigue of UHMWPE. In particular, γ-radiation and oxidative aging are very detrimental to the fatigue threshold and crack propagation resistance (Table 2). Moreover, compression molding appears to render a better fatigue resistance when compared to extrusion.

Table 2 Effect of processing conditions on the fatigue threshold (∆Kth) of UHMWPE 

1. 3 Effect of Composite Lamination:

Nanolaminates' layer of interpenetrating-networked composites such as those found in nature have unique fracture resistance. Examples are seashells which have been shown to yield improved fracture resistance with unique wear characteristics (see Figure 3). The microstructure is made of nano brick-type arrangement of ceramic phase sandwiched by ultra-thin polymeric protein layers. Presumably, the small brick-like ceramic components (often biodegradable) allow easy removal/dissolution, a concept which needs to be mimicked in engineering a biomaterial that has wear debris which is eco-compatible. By using the laminate concept, fracture toughness reaching values as high as 16 MPa√m can be achieved — as in the case of boron carbide/aluminum laminates. These laminates also have high flexural strength.



Figure 3 Fracture toughness versus specific flexural strength of some bioceramics and nanolaminates of metal matrix-ceramics composites. Note the effect of laminates in improving both fracture toughness and flexural strength.

Microlaminates of interpenetrating-networked composites (Figure 4) can be produced by bi-axial stretching of one crystalline phase (UHMWPE) or by infiltrating with elastomeric polyurethane (PU) . These microlaminates show significant improvement in strength and fracture toughness, and are used for elastomeric composite membrane (less than 40 µm) in biomedical application.



Figure 4 (a) Bi-axial stretching of UHMWPE and infiltrating with elastomeric polyurethane (PU) to produce microlaminates with significantly improved mechanical properties; (b) cross-sectional view of internal microstructure