Mechanical and Industrial Engineering-College of Engineering-Sultan Qaboos University

Development of High Density Polyethylene Micro/Nano-Hydroxyapatite Composites for Medical Implants

Mohammed Sulieman Al.Owiemri

Abstract

Due to the distinct rise in the number of medical cases that require reconstructive surgeries worldwide, the medical implants have increased accordingly in the past two decades. Through it, several orthopedic diseases, defects, traumas and congenital anomalies such as bone cancer, bone fracture, and osteoporosis can be treated or improved. Therefore, in order to improve, substitute, repair or enhance bone health, there is a vital and essential necessity for synthesizing biomaterials with special characterizations. However, this kind of implants are still considered a substantial challenge and a huge burden on the quality of healthcare. Hence, finding such safe devices, with minimum complications, made of synthetic biomaterials can offer the bone graft field a promising alternative. Recently, polymers are being more widely used in the medical field these days due to their widespread availability and very simple product development and manufacturing procedures. This is in addition to the lower cost as compared to other materials. High density polyethylene is one of the frequently employed in medical applications due to its mechanical strength, low cost, great biocompatibility, ease of processing, and chemical and biological resistance. The main aim of this project is to develop the local Polyethylene material to be used as a medical implant. This material is characterized according to its mechanical properties such as (tensile, flexural, compression and impact properties) are considered one of the most important properties that must be taken into consideration in such studies. To achieve this goal, some materials must be combined with each other to obtain a product that with properties similar to those of bone. This process is reinforcing High-Density Polyethylene (HDPE) with a bioactive hydroxyapatite (HA) ceramic was developed to produce bioactive composites for bone replacements. The experimental work studied the selected mechanical properties of the locally produced High-Density Polyethylene (HDPE) reinforced with hydroxyapatite (HA) ceramic nanoparticles (NPs) and micro particles (MPs) with diameters of 200 nm and 200 µm respectively. HA MPs vi

of 1, 5, and 10 wt% and HA of 0.5, 1, and 5 wt% were blended with the HDPE using twin screw extrusion machine. The mixing process performed at 200 rpm and 220 °C.

The result of this research indicates that, HDPE/Nano-HA composites achieved higher property values than HDPE/Micro-HA composites for most of the mechanical tests. The standard deviation values are reasonable, indicating that the experimental work is repeatable. The coefficient of variation is significantly below 10, indicating that the results are also reliable. The best value of UTS may be obtained at 1 wt% Nano-HA, where it improves by roughly 33.8 % to neat HDPE.