Study of Polymer Materials used as Biomaterial

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Abstract— **In the medical there is a considerable development in surgery and prosthetic fields. For this purpose a lot of materials are used as implants for replacing them in place of damaged parts. These materials are called as bio materials, but biomaterials should have a very good properties for implants. SS-316L has established itself as the best available bio implant material. With the advancement in the field of material science, metallurgy and designing, the development for more advanced bio materials having better properties than SS-316L and other related materials**

Implants can be obtained only solving the problem which is occurred through biomaterial properties which occurs when interacting with the body and the blood and a good properties always required for the implants. And also for solving the problem for the biomaterials a easy implant is required by easing the problem by seeing all the properties of the biomaterials. Bio-materials are the very important materials for the purpose of implantation with biocompatibility where the blood should interact with bone and also implanted material this can be done with various test and analysis like tension, compression,corrosion test with getting all the properties of the material but DENSITY of the material is very important for the biocompatibility and this can be obtained by the Polymer materials and shown polymer materials is the best suitable biomaterials for implantation

Keywords—Polymer Biomaterial, Femur Bone, Biocompatible

I INTRODUCTION

Biomaterials are materials (synthetic and natural; solid and sometimes liquid) that are used in medical devices or in contact with biological systems. Biomaterials as a field has seen steady growth over its approximately half century of existence and uses ideas from medicine, biology, chemistry, materials science and engineering. There is also a powerful human side to biomaterials that considers ethics, law and the health care delivery system. This brief introduction overviews some key characteristics of the field of biomaterials and outlines issues and major subdivisons[1]

A Biomaterial is defined as any systemically, pharmacologically inert substance or combination of substances utilized for implantation within or incorporation with a living system to supplement or replace functions of living tissues or organs. Biomaterial is any material[2], natural or manmade, that comprises whole or part of a living structure or biomedical device which performs, augments, or replaces a natural function".Biomaterial a material that can function as a whole or part of a device to treat, assist, replace an tissue, organ, or function of the body

Biocompatibility is a general term used to describe the suitability of a material for exposure to the body or bodily fluids. It is the ability of a material to perform with an appropriate response in a specific application and is very dependent on the particular application or circumstances. A material will be considered biocompatible in a specific application if it allows the body to function without any complications such as allergic reactions or other adverse side effects.Biocompatibility is not the same as sterility. Sterility is the treatment of a material to remove or destroy all living organisms including bacterial or fungal spores, and does not concern itself with the actual biocompatibility of the material[3].

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II IMPLANTS

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An implant is a medical device manufactured to replace a missing biological structure, support a damaged biological structure, or enhance an existing biological structure. Medical implants are man-made devices, in contrast to a transplant. The Implanted materials are Stainless Steel(SS316L), Aluminum and Aluminum Alloys, Titanium and Titanium Alloys, Polymers, Polyetheretherketone, Ceramics, Alumina Chromium & Nickel Alloys, An implant is said to have failed if it ceases to perform the function for which it was inserted.

It may be due to deformation, fracture of implant, loosening of fixator or if implant causes undesirable consequences like pain, infection or toxicity leading to rejection of implant.

Implant is said to have failed if it ceases to perform the function for which it was inserted It may be due to:

The biocompatibility of implant quality stainless steel has been proven by successful human implantation for decades. Composition, microstructure and tensile properties of titanium, cobalt chrome, zirconium and stainless steel and titanium alloys have been used for internal fixation is standardized in IS and ASTM material specifications. Metallurgical requirements are stringent to ensure sufficient corrosion resistance, nonmagnetic response, and satisfactory mechanical properties. Torsional properties of stainless steel screws are different from titanium screws. Stainless steel bone screws are easier to handle because the surgeon can feel the onset of plastic deformation and this provides adequate pre warning to avoid over torquing the screw[4]

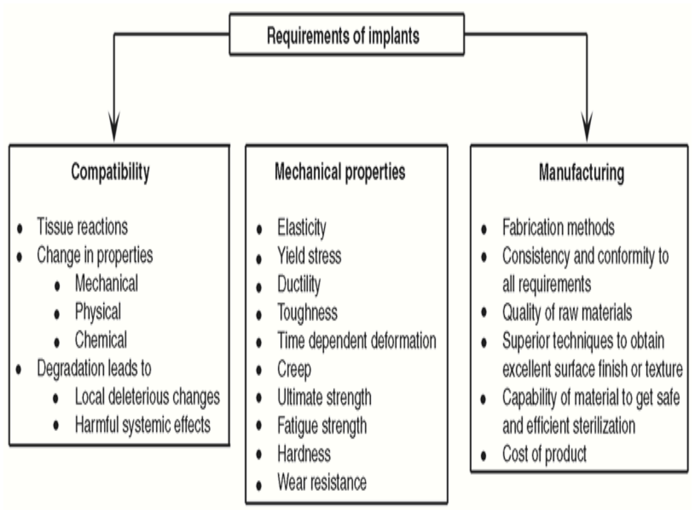

Figure 2.1: Implant Process flow chart

III BONE

The human skeleton is made of individual or fused bones (such as in the skull, pelvis and sacrum), supported and supplemented by a structure of ligaments, tendons, muscles and cartilage. Bones all have an arterial blood supply, venous drainage and nerves. The non-articular surfaces of bones are covered with a tough fibrous layer.

The skeleton is not unchanging; it changes composition over a lifespan. Early in gestation, a fetus has no hard skeleton; bones form gradually during nine months in the womb. At birth, all bones will have formed, but a newborn baby has more bones than an adult. On average, an adult human has 206 bones, but the number can vary slightly from individual to individual), but a baby is born with approximately 300 bones. The difference comes from a number of small bones that fuse together during growth, such as the sacrum and coccyx of the vertebral column. An infant is born with pockets of cartilage between particular bones to allow further growth. The sacrum (the bone at the base of the spine) consists of five bones which are separated at birth but fuse together into a solid structure in later years. Growing is usually completed between ages 13 and 18, at which point the bones have no pockets of cartilage left to allow more growth

Bone does not have same strength if loaded in different direction a property known as anisotropicity.Bone is less strong and less stiff when stressed from side to side.

Figure 3.1 Femur Bone

IV POLYMER MATERIALS

Polymers are substances containing a large number of structural units joined by the same type of linkage. These substances often form into a chain-like structure. Polymers in the natural world have been around since the beginning of time. Starch, cellulose, and rubber all possess polymeric properties. Man-made polymers have been studied since 1832. Today, the polymer industry has grown to be larger than the aluminum, copper and steel industries combined.

Polymers already have a range of applications that far exceeds that of any other class of material available to man. Current applications extend from adhesives, coatings, foams, and packaging materials to textile and industrial fibers, composites electronic devices, biomedical devices, optical devices, and precursors for many newly developed high-tech ceramics. Applications of Polymers:- [7]Polymeric materials are used in and on soil to improve aeration, provide mulch, and promote plant growth and health. Medicine: Many biomaterials, especially heart valve replacements and blood vessels, are made of polymers like Dacron, Teflon and polyurethane.

Polymers are attractive for Bio-Materials

- ✓ Improved and easier machinability
- ✓ Optical transparency for certain detection strategies
- ✓ Biocompatibility
- ✓ Acceptable thermal and electrical properties
- ✓ Ability to enclose high-aspect-ratio microstructures.
- ✓ Ability for surface modification and functionalization
- ✓ Biopolymers, including DNA and proteins are natural polymers
- ✓ Soft fabrication techniques often utilize polymer materials, both synthetic and natural.

Polyetheretherketone is a kind of excellent special engineering plastics, there are many notable advantage,

compared with other special engineering plastics, it has more remarkable advantages, bear heat, excellent mechanical property, perfect self-lubricating, corrosion proof, fire resistant, desquamate-proof, irradiation-proof, steady insurability, hydrolyze-proof and easy processing etc. extensively applied in aviation aerospace, auto manufacturing, electronic electric, medical treatment and food processing
Following Table shows the polymer used in biomedical applications with the specific properties

Polymer	Specific properties	Biomedical uses
Polyethylene	Low cost. easy processibiliiy. excellent electrical insulation properties, excellent chemical resistance, toughness and flexibility even at low temperatures	Tubes for various catheters, hip joint, knee joint prostheses
Polypropylene & Nylon	Excellent chemical resistance, weak permeability to water vapors, good transparency and surface reflection	Yarn for surgery, sutures
Polyvinyl chloride PVC	Excellent resistance to abrasion, good dimensional stability, high chemical resistance to acids, alkalis, oils. fats, alcohols, and aliphatic hydrocarbons	Flexible or semi-flexible medical tubes, catheter, inner tubes, components of dialysis installation and temporary blood storage devices.
Polyacetals	Stiffness, fatigue endurance, resistance to creep, excellent resistance to action of humidity, gas and solvents	Hard tissue replacement
Polyamide	Very good mechanical properties, resistance to abrasion and breaking, stability to shock and fatigue, low friction coefficient, good thermal properties, good chemical resistance, permeable to gases	PA 6 tubes for intracardiac catheters, urethral sound; surgical suture, films for packages, dialysis devices components, PA66 heart mirtal valves, three way valve for perfusion, hypodermic syringes, sutures

Table 3.1 Polymers materials used as Biomaterials

Other polymer materials used in medical appliances
1. Containers for blood, urine continence and ostomy products
2. Containers for intravenous solution giving sets
3. Heart and lung bypass sets
4. Catheters and cannulae
5. Tubing for dialysis, endotracheal, feeding and pressure monitoring
7. Inflatable splints
8. Inhalation masks
9. Blister packs for pills and tablets
6. Surgical and examination gloves

IV ANALYSIS OF MECHANICAL PROPERTIE OF BONE

From the age 10 years to 80 years the bone strength will not remains the same, the tension, compression bending, torsion of the bone variation takes place due to the improperties happen in the body the above column shows mechanical property of the bone and its percentage of elongation, the representation of the different mechanical properties of the bone will be shown by considering the age of the human body, The properties of any material are governed by its chemical composition and by the intra- and intermolecular forces that dictate its molecular organization. Macromolecular structure [8] in turn affects macroscopic properties and, ultimately, the interfacial behaviour of the material in contact with blood or host tissues
The majority of biomaterials used in humans are synthetic polymers such as the polyurethanes or Dacron (trademark; chemical name polyethylene terephthalate), rather than polymers of biological origin such as proteins or polysaccharides. The properties of common synthetic biomaterials vary widely, from the soft and delicate water-absorbing hydrogels made into contact lenses to the resilient elastomers found in short- and long-term cardiovascular devices or the high-strength acrylics used in orthopedics and dentistry

	Age (Years)						
Property	10-20	20-30	30-40	40-50	50-60	60-70	70-80
Ultimate Strength (Mpa) “Tensile Strength”							
Tension	114	123	120	112	93	86	86
Compression	-	167	167	161	155	145	-
Bending	151	173	173	162	154	139	139
Torsion	-	57	57	52	52	49	49
Ultimate Strain(%) “% Elongation at Break”							
Tension	1.5	1.4	1.4	1.3	1.3	1.3	1.3
Compression	-	1.9	1.8	1.8	1.8	1.8	-
Torsion	-	2.8	2.8	2.5	2.5	2.7	2.7

Table 3.2 Bone properties with Age

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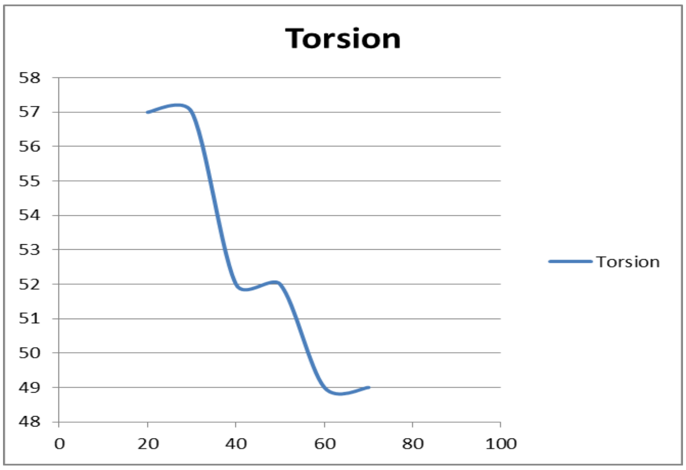
V METHODOLOGY OF PROPERTY OF BONE

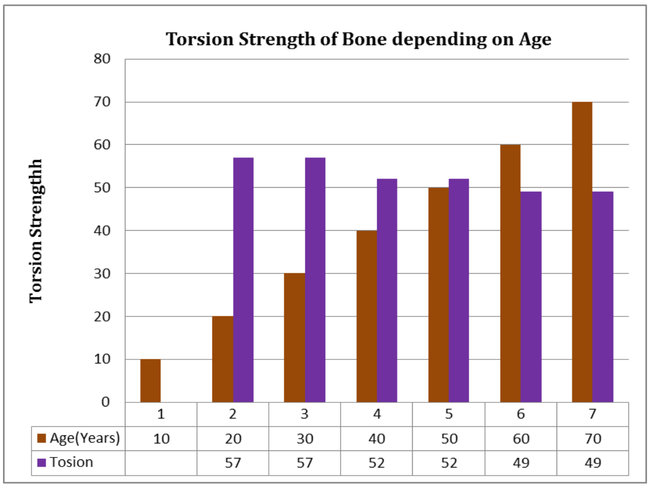
The above graph bar chart and table shows the property of bone which is related to the bone factor, the bone strength which depends on the age of the man which losses is mechanical strength at certain age, this can be rectified by the polymer materials

Age(Years)	Torsion
10	-
20	57
30	57
40	52
50	52
60	49
70	49

Table 5.1: Age vs Torsion Factor



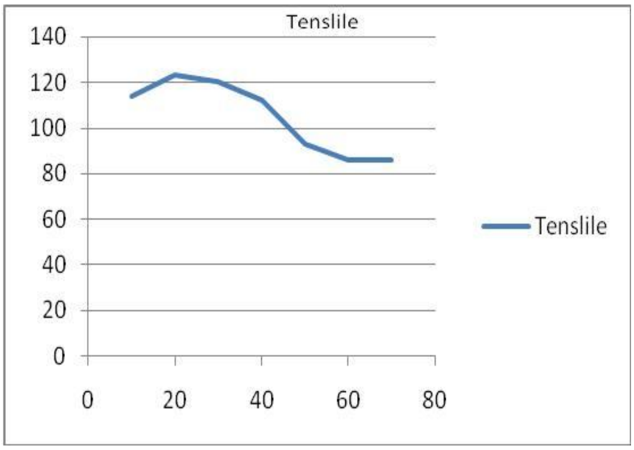
Graph 5.1: Graph showing Torsion Strength



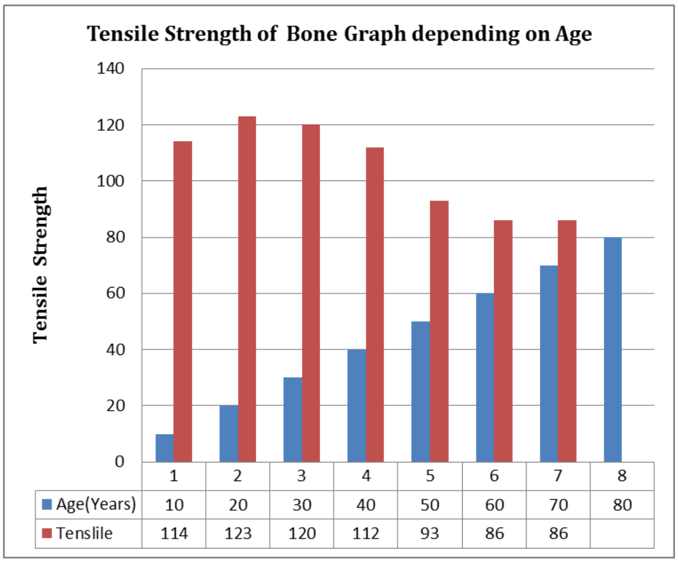
Graph 5.2: Bar Char of Bone Torsion Strength

Age(Years)	Tensile
10	114
20	123
30	120
40	112
50	93
60	86
70	86
80	

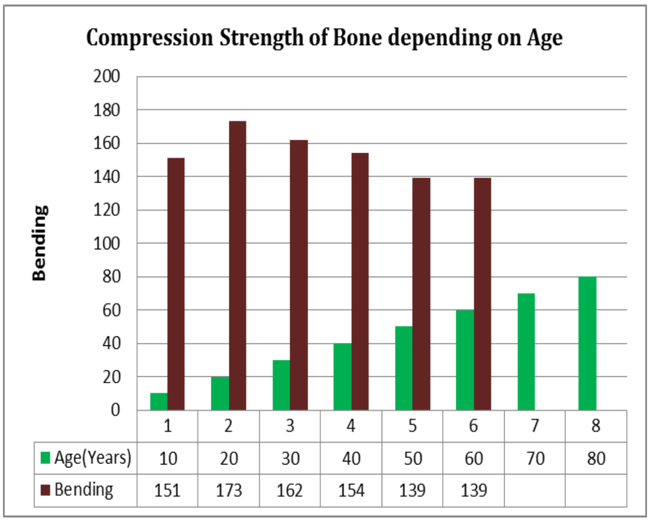
Table 5.2: Age vs Tensile Factor



Graph 5.3: Graph showing Tensile Strength



Graph 5.4: Bar Char of Bone Torsion Strength



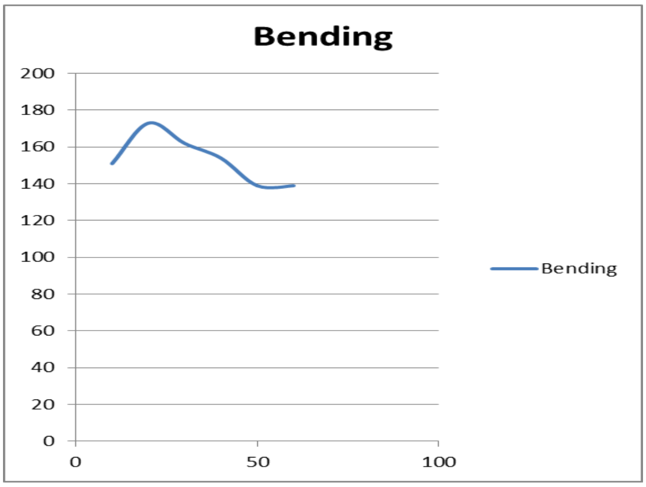
Graph 5.7: Bar Chart showing Bending Strength

Age(Years)	Bending
10	151
20	173
30	162
40	154
50	139
60	139
70	
80	

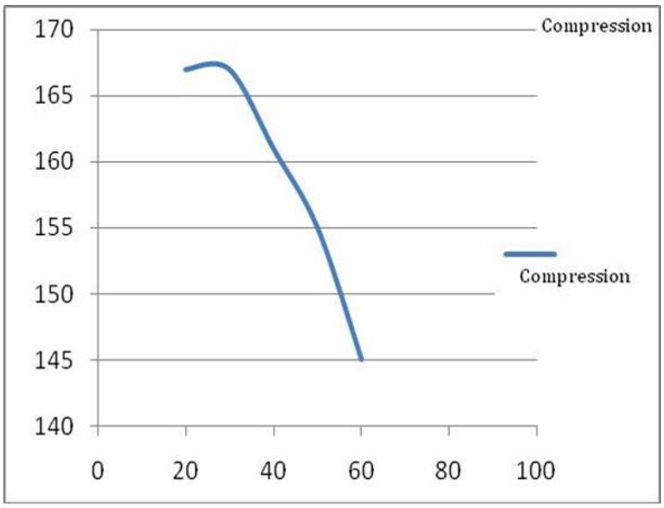
Table 5.3: Age vs Tensile Factor

Age(Years)	Compression
10	
20	167
30	167
40	161
50	155
60	145
70	
80	

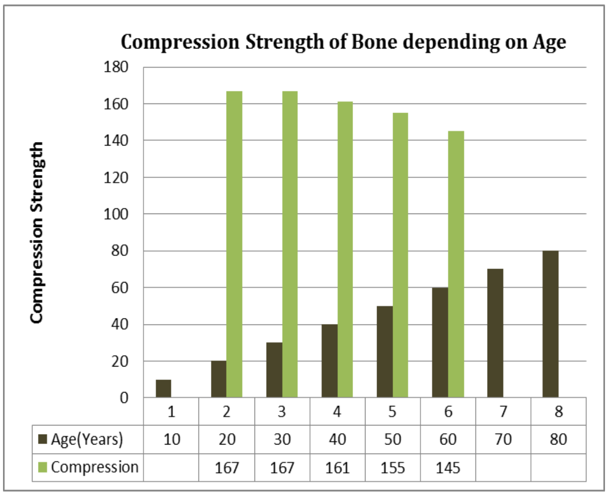
Table 5.4: Age vs Tensile Factor



Graph 5.5: Graph showing Bending Strength



Graph 5.6: Graph showing Bending Strength



Graph 5.8: Bar Chart showing Compression Strength

VI CONCULUSION

The process and investigation of bone which helps and shows that polymer material can be the material which equally acts and reacts for the feature biomaterials

- ✓ Polymer materials can be the best materials which suits the bone property
- ✓ Bone as good mechanical property by knowing the property of polymers it can be implanted for the feature implants.
- ✓ Polymers has highly corrosion resistance, wear resistance material.
- ✓ This material is highly biocompatible to human body, which makes the material to suitable for the implantation.
- ✓ The bone properties depends on the age varies with the factor of torsion, compression, tension and bending this factors would be always considered with polymer materials with the best mechanical properties for the further process which can be better implants.
- ✓ The study of polymer materials tells us the material with the all the basic process can be revealed with the highest quality of materials for the implants through the process.
- ✓ Among all the materials polymers can be the best replacement materials because its of good mechanical properties.
- ✓ The highest percentage of the polymers with the properties involves for better biocompatibility of the future reference to the materials with ceramics and metals.

VII SCOPE FOR FUTURE STUDY

There is a scope for future development in this dissertation work. Those are,

This dissertation work gives a brief idea about the BONE of bio compatible materials.

- ✓ Wear analysis can be done to see the characterstics of the materials..
- ✓ The study of the this work can be forwarded for polymers for implants.
- ✓ Polymer materials can be shown in the future as the best materials
- ✓ .Biomaterials as the wide range applications which can be used for the polymer materials, with the lot of advantages the research can be developed and it can be implanted for the better study in involving the material to the bio implants.
- ✓ The intersection of biomedical science and materials engineering is an exciting one, and largely falls in the province of biomaterials and tissue engineering. Many of the advances being made at the interface of these two disciplines are central to new medical and health-based technologies and are changing the way we live and treat illness
- ✓ As general medicine improves across the globe the average lifespan of the human increases, but with an average life expectancy of over 80 years in many developed countries the problem of age related illness or reliance on social care is a growing concern. The process of ageing can be a happy one but for many the idea of growing old and the negative effects involved are a cause of stress,

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