

# **Applications and Prospect of Plastics in Medical Instruments Industry**

## **1. Summary**

Plastics, a very important material, has been widely used in medical fields ranging from the packaging of drugs and reagents to utilization of disposable medical apparatuses (e.g.: infusion bottles and syringes) or non-disposable ones (e.g.: gauges and non-surgical instruments). It's predicted that medical plastics will become one of most potential branches among the plastics industry in the next decade.

## **2. Characteristics**

As celluloid--a high polymer material, was firstly used as a dialyzing membrane and successfully processed into artificial kidney for clinical applications in 1930s, the high polymer materials have been gradually replacing traditional inorganic materials thanks to their excellent properties, reliable performance and easier forming techniques. Thus, high polymer plastic materials are well-suited for medical applications due to outstanding physical/mechanical properties and chemical stability. Benefited from abundant sources and attractive price, high polymer materials are preferred options to disposable medical apparatuses, alleviating the problems of traditional materials such as: cost of multiple disinfection and cross infection. The plastics are easy to be formed and also compatible to tissues and blood. Meanwhile, plastics can be processed into complexly shaped new medical products due to ease-of-processing and lower manufacturing cost.

## **3. Clinical Applications of Plastic Medical Instruments**

- a. Circulatory system: polyether-urethane plastic materials mainly used for artificial heart are characterized by good elasticity, strong ageing resistance and compatibility to tissues and blood. The performance of products can be adjusted through molecular design. Other products also include: artificial cardiac valve, sheet for heart repair, artificial vascular graft and cardiac catheter, etc.
  
- b. Respiratory system: the plastic products associated with respirators are most extensively applied to medical instruments. The relevant products include: face mask, nasal mask, tracheal cannula, tracheotomy tube, bronchial catheter, connecting tube of respirator and various cannulas, most of which are made of polyvinyl chloride, polypropylene and rubber. The artificial lung, also called oxygenator, is composed of polypropylene hollow fiber and polysulfone

hollow fiber. Such artificial membrane oxygenator features good effect, safety and reliability.

- c. Digestive system: plastics is widely used in odontology of digestive system, covering: false teeth, dental base acrylic resin powder, full denture, denture lining and tooth curing resin, most of which are made of polymethacrylate copolymers. Also, the plastics can be commonly used in artificial throat, artificial esophagus, bile duct, nasal feeding tube, stomach catheter and intestine catheter.
- d. Kinematic system: Since metal joints are prone to desquamation, fatigue fracture and corrosion during long-lasting services, the plastic artificial joints are highly recognized thanks to such advantages as lightweight, excellent stability and self-lubrication. With extremely similar chemical components as compared with those contained in human bone tissue, excellent biocompatibility, the non-toxic, non-irritating, non-teratogenic and non-carcinogenic artificial bone pegs and bone cement are broadly used in orthopedics as they can be fully integrated into original bone to form firm synostosis.
- e. Urinary system: artificial dialyzer, which is used as an artificial kidney in treatment of renal failure and uremia, is an artificial organ broadly used in urology. It is mainly composed of cellulose, Polyacrylonitrile, Polymethyl methacrylate, polyvinyl alcohol and ethylene vinyl acetate, which are processed into flat membranous tubes and hollow fiber. Meanwhile, artificial urinary bladder, catheter and ureter are positively affirmed in clinical applications.
- f. Nervous system: artificial skull is mainly used for repairing cranial cavity after craniotomy with metal or plastic autologous and heterogenous osseous tissues. As compared with other materials, Polymethyl methacrylate for common plastic products features lightweight, good toughness and chemical stability, strong corrosion resistance, non-toxicity, ease-of-processing and insulation to electricity and heat. Plastic skull grafts with better quality are now used to clinical applications. It is necessary to note that, artificial nerve conduits are used to clinically repair damaged nerve. With emerging research on degradative plastics in the medical field, a major breakthrough is expected to be made in clinical practice, showing a great potential of commercial development. Furthermore, there is huge demand on catheters, drainage tubes

and cerebral arteries' angiographic catheter for brain surgery.

- g. Visual system: the commonly used plastic products include: artificial cornea and contact lenses(invisible glasses). Planting of artificial cornea is an outstanding problem due to the problem of compatibility of the implant with the human body. Now there is a huge market of invisible glasses. Also, plastic artificial ear and skin are used in clinical practice.
- h. Plastic products for nursing: disposable medical products include: syringe, infusion and transfusion apparatus, with a total market over 13 billion sets. Medical containers include: infusion bottle, infusion/transfusion bag and blood storage bag with remarkable consumption.

#### **4. Development Trend and Prospect of Medical Plastics**

The plastics can be more extensively used in medical fields due to excellent properties, stronger reliability, ease of forming and attractive price. Hence, there is an urgent need of developing new medical treatment, diagnosis, prevention and healthcare plastic products. The statistics show that, the output of global medical instrument market has reached US\$100 billion, and that of medical material market reached US\$12 billion, with an average increase of 7%--12%. As an emerging industry in China, the output of medical plastics in domestic market accounts for only 7% of developed countries. Amongst nearly RMB50 billion output from medical instruments, the medical plastics amounts to about RMB6 billion. It's estimated that, domestic market of medical instruments will increase by 40%. There are currently available with over 7000 registered medical instrument manufacturers and only about 1000 medical plastics manufacturers. Due to some factors such as fitness, most of plastic products are used middle-/small-sized cities and rural regions, whilst imported plastic products are used in big cities such as Beijing, Tianjin and Shanghai. There is a huge market room for the consumable plastic products, thus providing unlimited business opportunities for the medical plastics manufacturers.

Note: Xi Miaogen, originally a professor and chief physician of No. 411 Navy Hospital