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Fiber reinforced composite and surface coated esthetic archwires - a review

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ABSTRACT

Orthodontic treatment has undergone drastic transformation since few years. Many patients present with a set of challenges to orthodontists in terms of esthetics while undergoing orthodontic treatment. Introduction of composite & ceramic brackets has led to the development of esthetic archwires to meet the increased demand for esthetics during orthodontic treatment. This article discusses about widely used esthetic archwires used in orthodontic treatment.

1. Introduction

The number of adult patients seeking orthodontic treatment has been increased from the past few years. Esthetics, while undergoing orthodontic treatment, is one of the primary concerns in the present era due to the metallic show of the brackets and wires [1]. Although adult patients are better cooperative, their interest in esthetic brackets and wires have been increased significantly. Due to the increased demand for esthetics during orthodontic treatment, esthetic brackets and wires were introduced. Hence, this article is focused on giving an overview of various esthetic archwires available for the clinician to meet his/her patients' needs.

2. Manufacturing process of esthetic arch wires

The different manufacturing processes of esthetic archwires are described in the following sections.

2.1 Ion Implantation

The expedition of ions with the guidance of electric field, to implant them off the surface of solid (metal) [2].

2.2. Surface Coating

The surface of the archwires is coated with a polymer that masks the underlying metal component of the wire and making them aesthetic. Nitinol (Ni-Ti) and stainless steel (SS) wires are coated with Polytetraflouroethylene (PTFE), Epoxy Resin, to give the natural appearance of enamel. These wires possess excellent aesthetics and ensuring maximum efficiency.

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2.3 Pultrusion

It is the process of manufacturing components having continuous lengths and a constant cross-sectional shape. In this, bundles of continuous fibres are pulled through an extruder and impregnated with a polymeric resin (figure 1). These resin fibre bundles are cured followed by imparting the precise circular or rectangular shape.

2.4 Beta staging

It is an intervening process in which partially cured resin and the bundles of continuous fibres change their form after which the curing is completed. Preformed arch wires are possible by this process.

3. Composite archwires

Numerous advancements are made in the archwires without affecting their critical properties to meet the aesthetic demands [3]. Progress in the composite technology led to the development of transparent polymeric composite archwires.

3.1 Self-reinforced archwires

These are fibre free and Polyphenylene based polymers. They exhibit high yield strength, ductility and spring back.

3.2 Fibre reinforced composite archwires (FRC)

These archwires are manufactured by the "Pultrusion" Process. FRC archwires possess excellent esthetics with superior tensile strength and elastic recovery. Further, FRC archwires are biocompatible as they are nickel-free. In certain situations, these arch wires can be bonded directly to teeth, thus, eliminating the need for brackets. In addition, welding and soldering of attachments to these wires are not required as attachments can be bonded directly. These wires are available in various shapes and dimensions. These archwires have a higher coefficient of friction compared to Stainless steel wires but lesser compared to Nickel-Titanium wires and Beta-Titanium wires. Abrasive wear of composite was noted at high forces at bracket-archwire interface.

A new FRC wire such as "Splint it" was introduced, recently. Splint it archwire consists of S2 glass fibres [4] in Bis-GMA matrix. These archwires are pre-polymerized during the manufacturing process and are polymerized to its full extent during treatment. They are used as retainers for retention and to reinforce anchorage [5] as they can be bonded directly to teeth. The significant advantages of this wire include superior flexibility, ease of adaptation and contouring over the teeth.

Optiflex is a most aesthetic orthodontic arch wire designed by Dr. Talass [6] and manufactured by ORMCO. It possesses superior aesthetic appearance as it is made of clear optical fiber. This optical fiber is composed of 3 layers. Inner core is silicon dioxide core, middle layer is made with silicon resin and the outer layer is nylon layer. Core provides the force for moving tooth, middle layer protects the core from moisture and also provides strength and the outer layer prevents damage to the wire and also further increases the strength [7] Optiflex is very flexible and is effective in moving teeth using light continuous force [8].

4. Surface coated archwires

The surface of metallic archwire was coated with a polymer to ensure maximum esthetics (Figure 2). Initially, these coated archwires were used in 1970's.

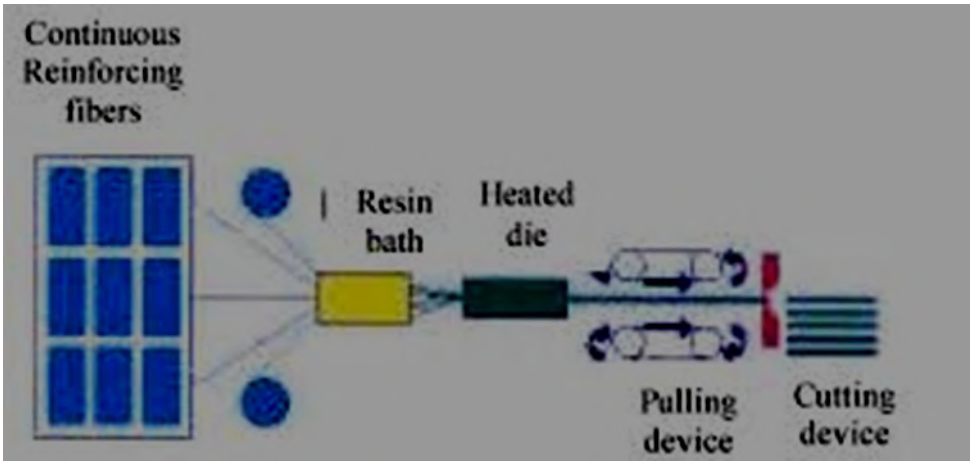

Figure 1: Pultrusion process

Figure 2: Surface coated arch wire

However, their usage was decreased later due to chipping of these coatings and denudation of the metal. Commonly used coated archwires are Teflon coated, and Epoxy resin Coated wires.

4.1 Teflon coated archwires

DuPont Co. introduced Teflon coated arch-wires. These wires are manufactured either by electrostatic technique or by thermal spraying. This coating protects the wire from corrosion. The molten material is sprayed on to the surface of the metallic archwire to ensure a coating. Nickel- Titanium and stainless steel wires are coated with Polytetrafluoroethylene (PTFE) and are called as Teflon coated wires. Usually, the thickness of the coating is 0.002 inches. These archwires are available in natural tooth shades with the hue that is comparable to that of the tooth. Hence, these wires possess excellent esthetics. These archwires are also available in different colours including, blue, green and purple. These wires have the lowest coefficient of friction and can be used for sliding mechanics.

Marsenol is a tooth coloured elastomeric poly tetra fluroethyl emulsion (ETE) coated nickel-titanium wire. The working characteristics of these wires are similar to an uncoated super-elastic Nickel-Titanium wire [8].

4.2 Epoxy coated archwires

Epoxy is a synthetic resin material with an excellent adhesion capability to the metal surfaces. This unique bonding character made this material to use frequently for coating of metallic wires. The electrostatic coating method is used to apply epoxy resin on the Nickel-titanium or stainless steel wires. The thickness of the coating is limited to 0.002 inches, as the increased thickness may affect the mechanical properties [9,10]. These wires are tooth-coloured and have colour stability which lasts for 6-8 weeks. These wires have excellent dimensional stability, chemical resistance and better stain resistant compared to other esthetic archwires. The esthetics of these wires is very much close to that of the colour of the natural tooth as they blend with the ceramic or plastic brackets [11]. All the coated archwires are available in various sizes and shapes.

Lee white wires were manufactured by LEE pharmaceuticals. It is resistant stainless steel or Nickel titanium archwire bonded to a tooth-colored epoxy coating. The completely opaque epoxy coating opaque does not chip, peel, scratch or discolour [8].

5. Conclusion

Esthetic archwires are visually perceptive and pave the way for clear labial orthodontic treatment by meeting the patient needs. Although there are few inhibitions concerning to mechanical wear, with the advanced technology these constraints shall be overcome, making esthetic archwires more widely accepted for treatment.

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