



# Pigment Coating on Polyether Ether Ketone Filament

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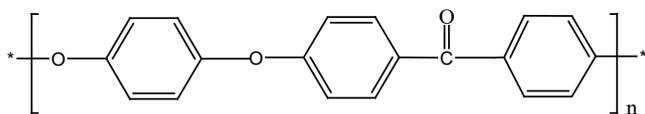
## Abstract

The present work was done to coat the high performance PEEK monofilament by pigment for special purpose textile such as temperature and heat resistant fabric. It was coated with black colored pigment and thermo fixed at 1600 C for 5 minutes along with the reflectance and color strength K/S value, wash and rubbing fastness was evaluated. The spectrophotometric results such as reflectance % and K/S value show that the pigment was coated uniformly on the filament surface. The wash and rubbing fastness results showed that coated filament gives good fastness properties. This work was done at the Central Dyeing Laboratory of Microfibre Group in Bangladesh from February to April 2017.

**Keywords:** PEEK, pigment, coating.

## I. Introduction

Polyether ether ketone (PEEK) is an organic semi-crystalline (35%) linear polycyclic aromatic thermoplastic polymer was first developed by a group of English scientists in 1979 (Patel *et al.*, 2011). It has a glass transition temperature (T<sub>g</sub>) at around 143°C, a continuous use temperature of 260°C, melts (T<sub>m</sub>) at around 343°C and on set of decomposition occurs at temperatures between 575 and 580°C, making it one of the most thermally stable thermoplastic polymers (Pawson *et al.*, 1992). As a member of the poly aryl ether ketone family, it has an aromatic molecular backbone, with combinations of ketone and ether functional groups between the aryl rings (Narushima *et al.*, 2009). Figure 1 shows the chemical structure of PEEK.



**Figure-1:** The chemical structure of PEEK

However, non-absorbable materials such as polypropylene (PP) and polyethylene terephthalate (PET) are more commonly used; the use of polyether ether ketone (PEEK) is increasing in regularity. Many research works have been carried out to coat the PEEK filament. Various materials have been deposited on the surface of PEEK, including copper (Narushima *et al.* 2009), silver (Foisal *et al.* 2014, 2017, Hasan

*et al.* 2013), titanium (Ti) or gold (Yao *et al.* 2007), hydroxyapatite (HA) (Barkarmo *et al.* 2013, Suska *et al.* 2014), titanium dioxide (TiO<sub>2</sub>) (Shan *et al.*, 2008, Harle *et al.* 2006), diamond-like carbon (DLC) (Wang *et al.* 2010) for technical purposes. In this consequence, this work was an effort to coat the pigment color on the filament surface to integrate it in the temperature and heat resistant Textile materials. As the surface of the PEEK filament is inert and it is difficult to integrate the dyes and chemicals on the surface. It requires surface modification. But in this work, pigment was coated with the help of binder and thermofixed at 160°C for 5 minutes.

## II. Materials and Methods

### Materials

PEEK (Polyether ether ketone) monofilament 99.7 Decitex with breaking load 4.1N, elongation 36.1%, Tenacity 40.8 cN/Text and shrinkage 0.9% collected from Zyex, UK.

### Coating Procedure

At first the coating solution was prepared according to the recipe illustrated in Table 1. The required amount of PEEK filament was cut by scissor and the surface was wiped with tissue paper. The amount of coating solution was taken and evenly coated on the surface of filament. The individual coated filament was placed on the tray

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of drying machine in parallel. Then, the tray was placed into the drying machine and set up 160°C temperature for drying. After 5 minutes, the sample was collected from the tray of drying machine.

**Table 1:** The chemicals used for the coating procedure

Pigment Black HFN	0.414 parts
Pigment Blue F2GL	0.483 parts
Titanium powder TiO <sub>2</sub>	0.276 parts
Binder OB-45	25 parts
Thickener	3 parts
Urea	3 parts

### Wash Fastness

The color fastness to wash of the coated filament was measured to find out its fading or color change, on exposure to a given agency or treatment. For the colored sample ISO105 C03 method was followed.

### Rubbing Fastness

Color fastness to rubbing means the resistance of color of colored materials to rubbing. Rubbing fastness of the sample was measured in ISO105X12:1993 method.

### Reflectance% and Color Strength K/S Value Evaluation

The reflectance % and color strength K/S value of the colored filament was analyzed by Color measuring instrument Spectrophotometer (Data color) which determines the K/S value of filament through Kubelka-Munk equation as follows:

$$\frac{K}{S} = \frac{(1 - R)^2}{2R}$$

where R = reflectance percentage, K = absorption co-efficient and S = scattering co-efficient of dyes. This value represents the attenuation ratio of light due to absorption and scattering is found based on reflectance.

## III. Results and Discussions

### Pigment Coated Sample

Figure 2 shows the original PEEK monofilament (a) and pigment coated black colored filament (b). The

filament was natural coloured without any finished chemicals on the surface before coating and after coating the sample was evenly pigment coated on the surface.

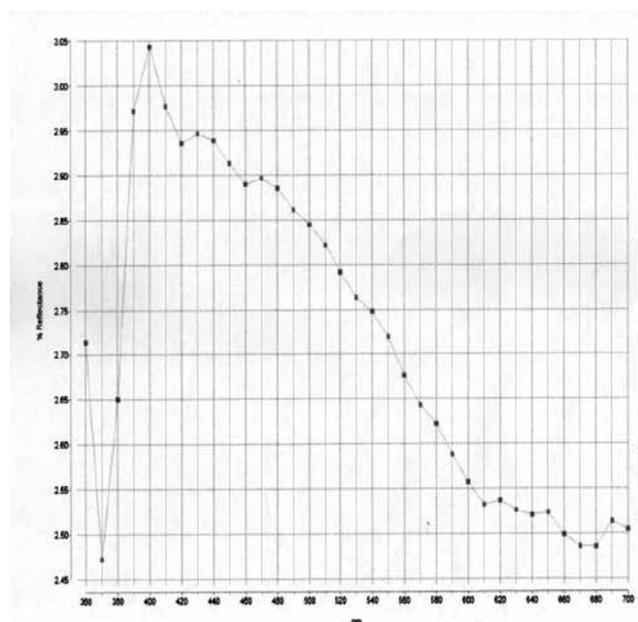


a) Before coating the original PEEK filament      b) After coating the black colored PEEK mono filament

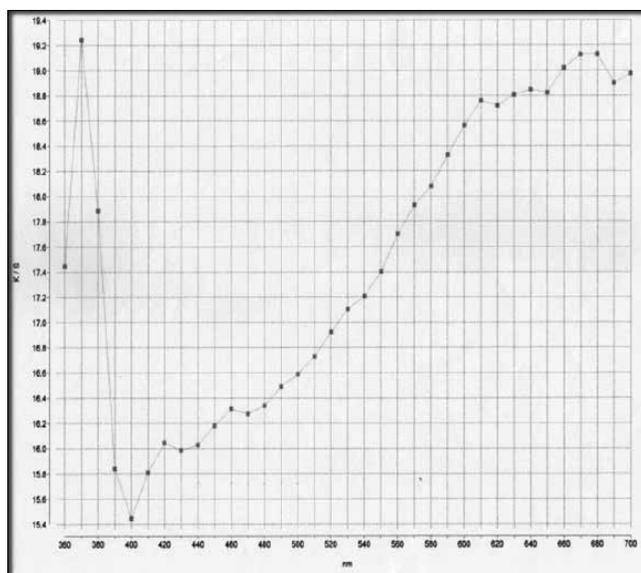
**Figure 2:** a) the sample as natural colored filament and b) black colored filament after coating

### Evaluation of Reflectance (%) and Color Strength (K/S) of PEEK Filament

The reflectance (%) and K/S value of coated filament sample was evaluated. The Figure 3 shows the reflectance (%) and color strength (K/S) values of pigment coated filament sample at 360-700 nm wave length. For 400nm wave length the reflectance (%) was 3.04% and the color strength (K/S) value was 15.46. For higher wave length i.e. 640nm, lower the reflectance (%) i.e. 2.52% and the color strength (K/S) was higher i.e. 18.85 respectively.



a) Reflectance % vs Wave length Curve



b) K/S vs Wave length Curve

**Figure 3:** a) Reflectance % and b) K/S curve on the basis of wave length in nm

The reflectance (%) and the color strength K/S values of a coated filament were opposite. From results it was observed that the reflectance (%) was 2.98%, 2.94%, 2.95%, 2.94%, 2.91% and the color strength (K/S) value was 15.79, 16.02, 15.96, 16.02, 16.19 for 410 nm, 420 nm, 430 nm, 440 nm, 450 nm wave length respectively (fig. 3a and 3b) and for 640 nm, 650 nm, 660 nm, 670 nm, 680 nm, 690 nm lower the reflectance (%) i.e. 2.52%, 2.52%, 2.50%, 2.49%, 2.49%, 2.51% and the color strength (K/S) was higher i.e. 18.85, 18.85, 19.01, 19.09, 19.09, 18.93 respectively (Figs. 3a and 3b).

### Wash Fastness

From the table 2 it was found that the change in color was 4-5 in grey scale rating which indicates that the fastness result was very good.

**Table 2:** wash fastness results of the pigment coated filament

Color	Wash fastness
Black colored filament	4 - 5

### Rubbing Fastness

From the table 3 it was seen that the dry rubbing of the pigment coated PEEK filament was 4 - 5 which was very good in grey scale rating. Moderate rubbing fastness (wet) was achieved with fastness grade 3-4.

**Table 3:** Rubbing fastness results of the pigment coated filament

Color	Rubbing fastness (dry)	Rubbing fastness (wet)
Black colored filament	4-5	3 - 4

## IV. Conclusion

The target of this work was to find out the potential of pigment coating on PEEK filament surface through the application of pigment print paste along with the fixation temperature and time which have significant role after coating. It was observed that the coating was done properly from the reflectance % and K/S value. It was also observed that the wash and rubbing fastness of pigment coated filament was good. The usefulness of the pigment coated PEEK filament for woven and knitted fabric can be evaluated for value added such as temperature and heat resistant Textile purposes.

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