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Study the Optical and Morphological Properties of Prepared PANI/TiO2 Nanocomposites

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Abstract. Inorganic-organic hybrid materials are of the materials of interest to researchers for the purpose of developing them in this work. A hybrid material consisting of conductive polymer polyaniline (PANI) doped with dodecyl benzene sulfonic acid (DBSA) $C_{18}H_{30}O_3S$ with titanium oxide nanoparticles (TiO2 NPs) was prepared by the direct chemical polymerization method, and then the optical and surface properties of the prepared materials were studied by UV-VIS spectroscopy, Scanning electron microscopy SEM , and Energy Dispersive X-Ray EDX. The EDX results confirm the presence of TiO2 in the composite material .The results clearly demonstrate that the composite films have good optical properties. As the content of TiO2 was increased in the polymer matrix, the shift of the optical absorption was observed.

Introduction

A significant advantage of conducting polymers is that they are simple to produce, and their chemical structure may be tailored to adjust their physiochemical features, for example their band gaps. They exhibit a wide-ranging range of conductivities from metals to insulators (10^{-9} -10^{5}) S/cm, with the highest conductivity being metal. Additional to the easiness of production and reduced costs, they are known to have mild poisoning effects, which makes them an attractive alternative. In practical applications, Polyaniline is one of the most important types of conductive polymers for several reasons and features that make it this position like its outstanding ecological stabilities, ease of production, great temperatures resistance, and remarkable electric conductivities with diverse kinds and dopant concentration [1-4].

Inorganic materials such as Iron oxide Fe2O3, titanium oxide TiO2, manganese oxide MnO2, Tin oxide SnO2, and other similar materials are combined with conducting polymers to improve their properties in the application of optoelectronics, catalytic properties, antimicrobial activities, water treatment and storage applications, among other things etc.[5].

Over the last few years, the Pani:TiO2 nanocomposite has received increased interest [6-8]. Increased conductivity of Pani is achieved with the insertion of TiO2 nanoparticles, whereas increased dispersibility of TiO2 nanoparticles in macromolecules is achieved through the addition of a surfactant [9].

When it comes to the synthesis of PANI/TiO2 nanocomposites, there are a variety of methods to choose from, including template production [10], direct physical mixing [11], and insitu polymerization, which is an extremely effective technique of production of conductive polymer nanocomposite that occurs "in the polymerization mixture." It entails the incorporation of nanomaterials into a solution mixture holding a neat monomers, tracked by the polymerization of the solution mixture. The formation of covalent bonds between the nanomaterial and the matrix occurs in this method [12].

It is becoming increasingly popular to combine PANI with inorganic materials such as semiconductor nanostructures because of the wide range of applications that may be achieved with this combination. They possess features that are strikingly different from those of common inorganic dopant of some acids, and they are essential in the manufacture of electronic tools with better electric, magnetics, and optic capabilities. In comparison to traditional inorganic dopants of mineral acids, PANI/TiO2 nanocomposites containing ammonium per sulfate exhibit significantly different features, and they were crucial in the manufacture of electronics tools with higher electric, magnetic, and optic capabilities [13-17].

PAni/TiO2 hybrids were generated using chemical in situ methods in which PAni was polymerized by a simple chemical oxidative process. The hybrids were then examined by UV-VISIBLE spectroscopy, FESEM, EDX and XRD.

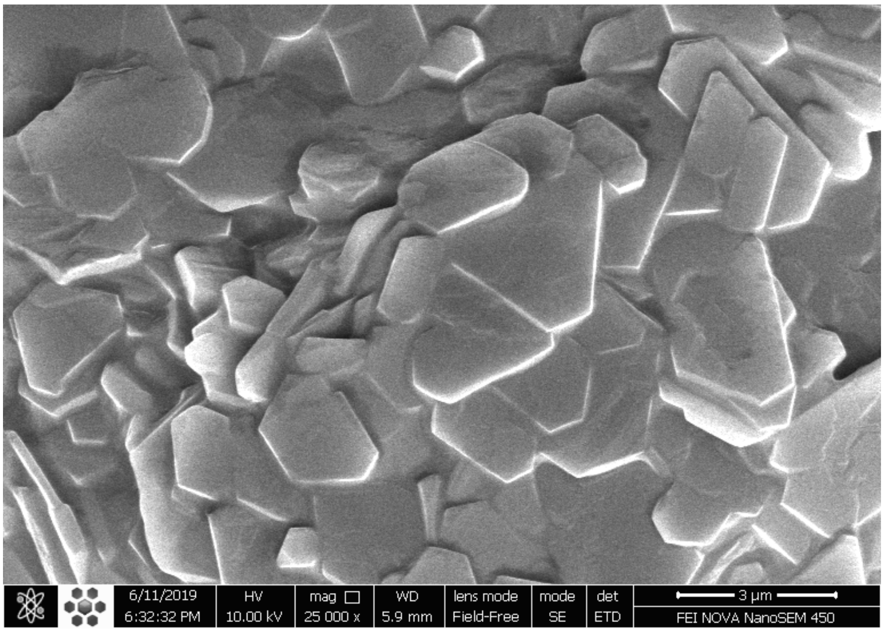
Experimental

Chemicals syntheses of DBSA-Doped PAni

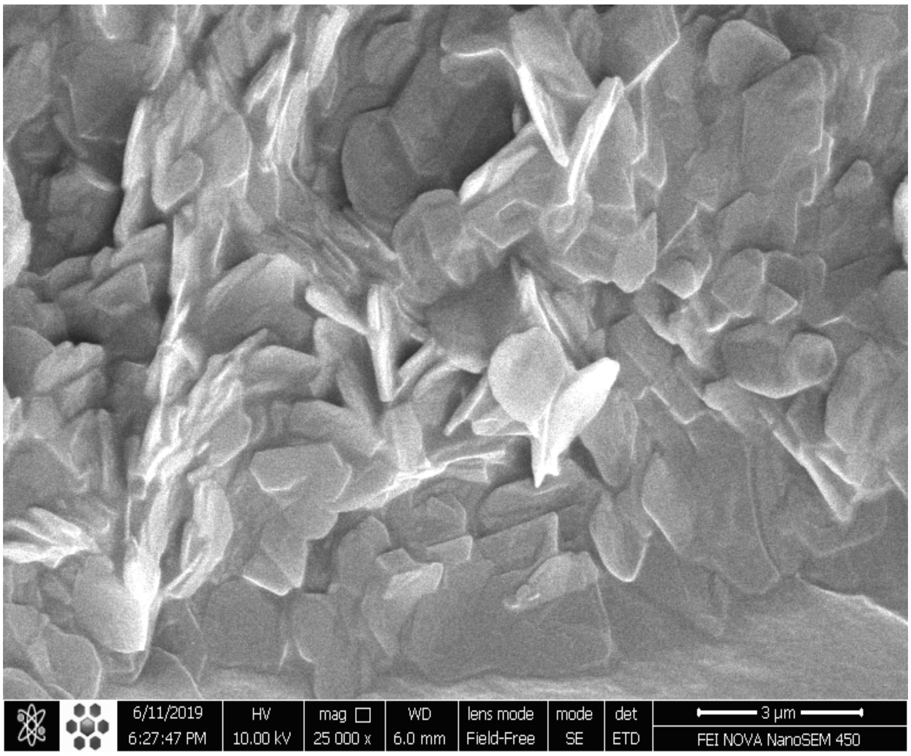
The synthesis of DBSA-doped PANI was based on the typical oxidative aniline. 1.5 ml of deionized water was added into 1.14gm of ammonium persulphate (APS), while 25 ml of heptane (C_7H_{16}) was added into 6.525gm of dodecyl benzene sulfonic acid (DBSA). Solution APS and DBSA were mixed by stirred for 30 min at room temperature to produce homogenous solution (A). 0.93gm of aniline was dissolved in 5 ml of haptane and 0.5 ml of ethanol to form another solution (B). The solution A and B mixed together for 24 h by stirred at room temperature. The precipitate was cleaned by washed in deionized water and methanol, then dried for 24 h at vacuum oven. Undoped PANI (EB-PANI) can yield by washed some powder from PAni-DBSA into ammonium solution. The nanocomposites preparation was done by same procedure above by adding TiO2 to the aniline monomer (5% and 10% weight ratio from monomer) .

Results and Discussions

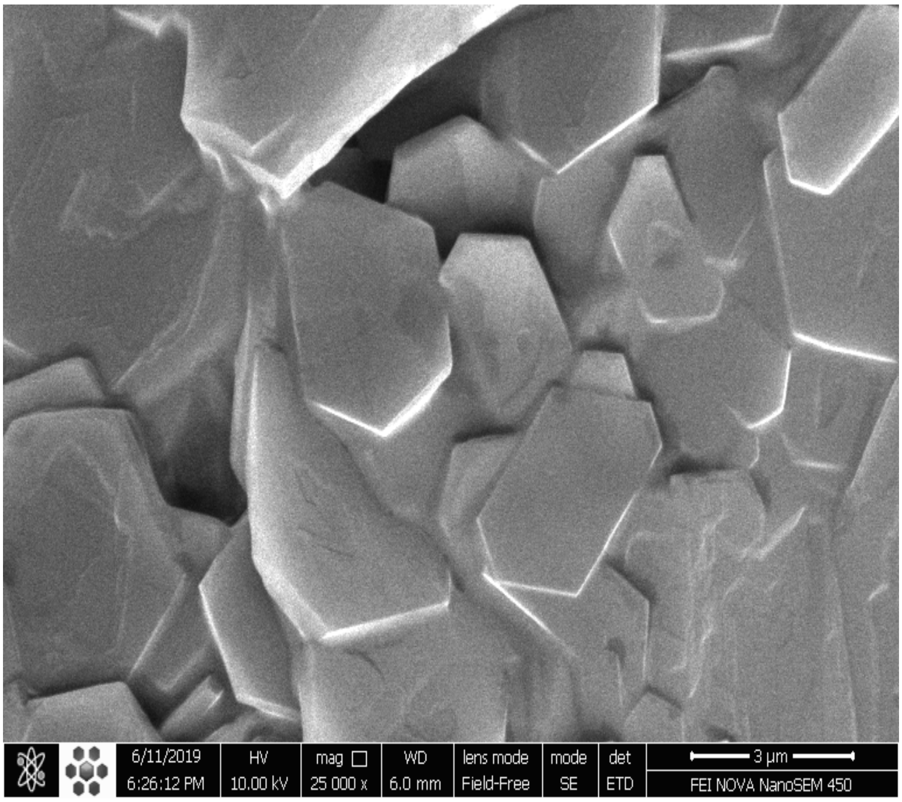
Figure 1 depicts the shape of Polyaniline and A Polyaniline/TiO2 composites with varied amounts of B (10 percent weight percent) and C (20 percent weight percent). It can be seen in the image above that the shape of the composite is plate-like for all samples with comparable sizes, whether they are pure Pani or its composites.



A



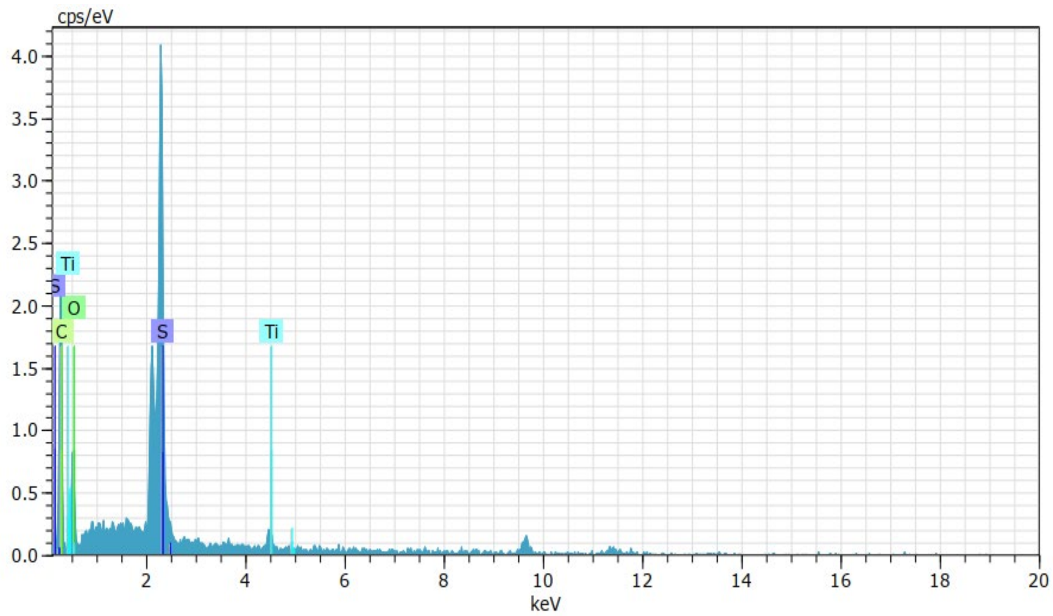
B



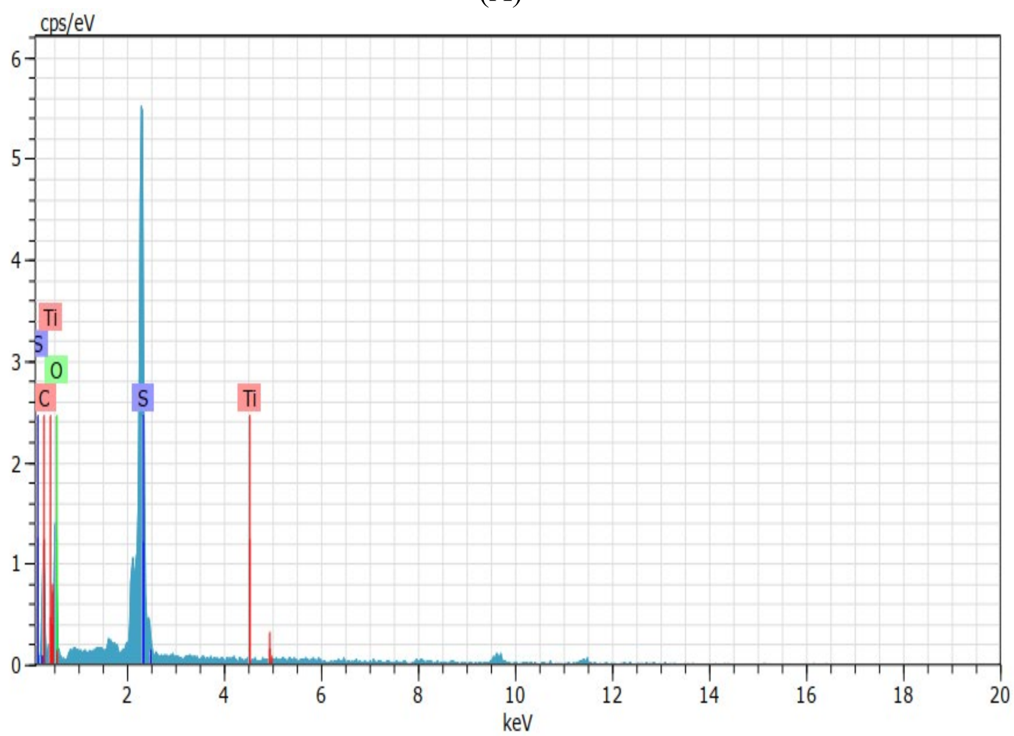
C

Figure 1. SEM Image A) Polyaniline , B) Polyaniline/TiO2 10%, C) Polyaniline/TiO20%

Figure 2 shows the EDS spectra of the samples. The presence of TiO2 on the surface of all samples was confirmed by EDS spectra at each of the locations investigated. The elements of the composite are represented in the tables 1 and 2.



(A)



(B)

Figure 2. EDX OF PANI/TiO2 Nanocomposites, A) 105 TiO2, and B) 20 % TiO2

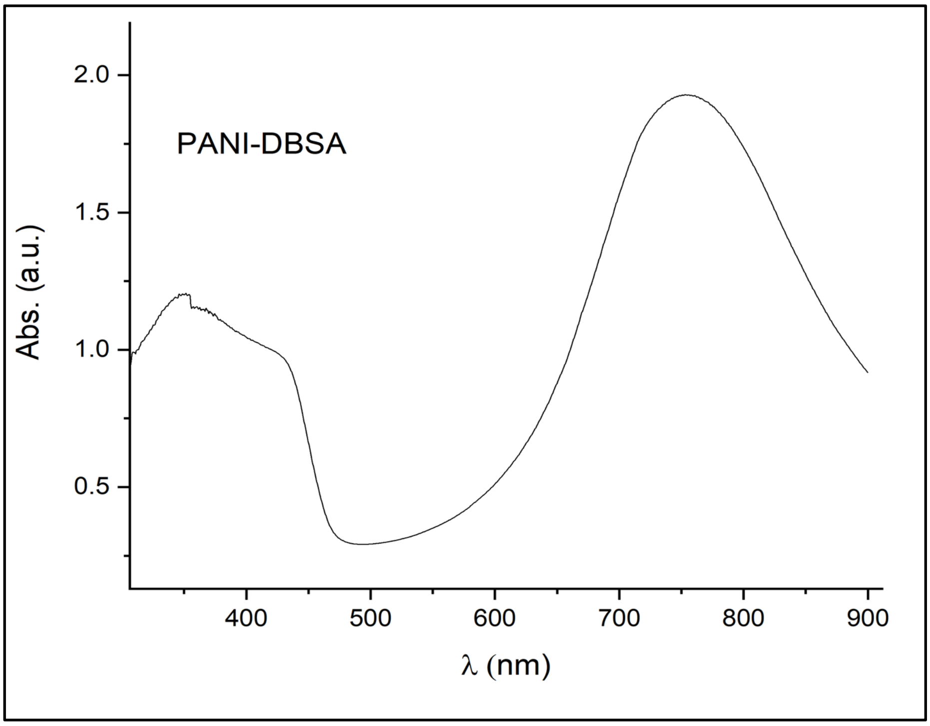
Table 1. Elements ratio from EDX OF PANI/TiO2 Nanocomposites(10% TiO2)

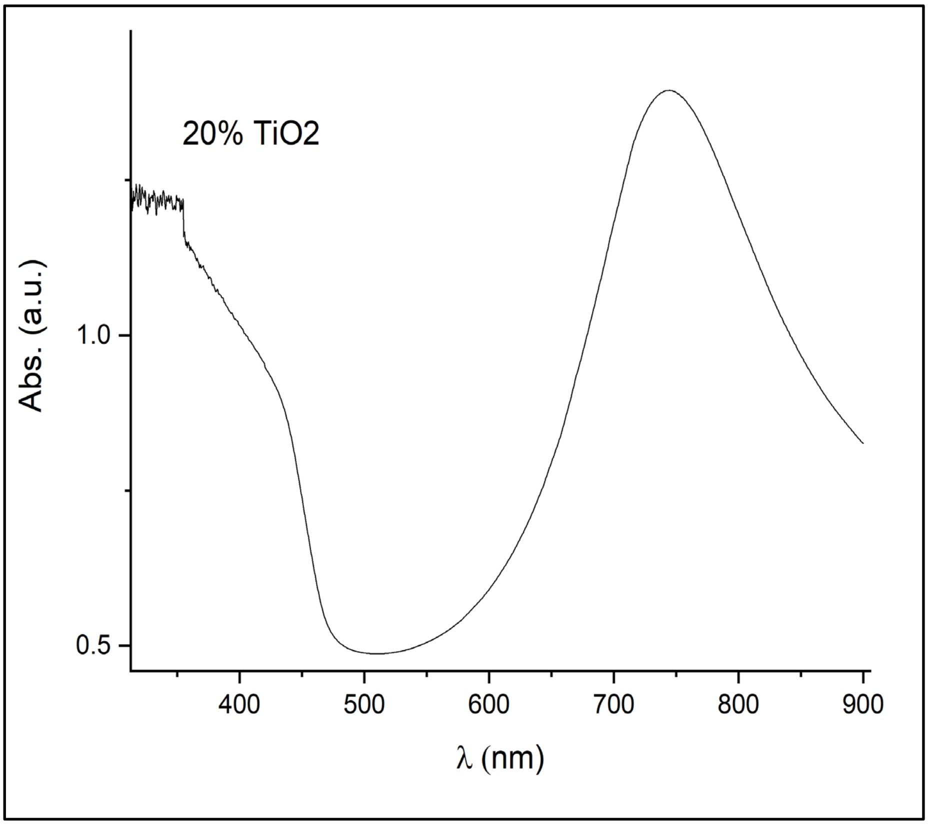
Element	Series	Ratio (Wt%)	Ratio (at%)
C	K	63.75	75.92
O	K	20.27	17.97
S	K	15.80	6.97
Ti	K	0.17	0.05
Total		100.00	100.00

Table 2. Elements ratio from EDX OF PANI/TiO2 Nanocomposites(20% TiO2)

Element	Series	Ratio (Wt%)	Ratio (at%)
C	K	62.18	73.28
O	K	23.07	20.41
S	K	13.41	5.92
Ti	K	1.35	0.40
Total		100.00	100.00

Because of the importance of the optical properties of these materials have been studied by many researchers [18-20].Following is a representation of the absorption spectra of PAni and the PAni-TiO2 nanocomposite (10 percent and 20 percent, respectively) as well as their relative concentrations in Figure 3. In the instance of PAni, two large absorption bands have been seen in the wavelength ranges of 300–450 nanometers and 650–800 nanometers, respectively. As a result of the observations, it is concluded that the TiO2 nanocomposite exhibits PAni-like properties at wavelengths ranging from 650 to 850 nm, and that the electrons of TiO2 in the valence band interact with HOMOs of PAni.





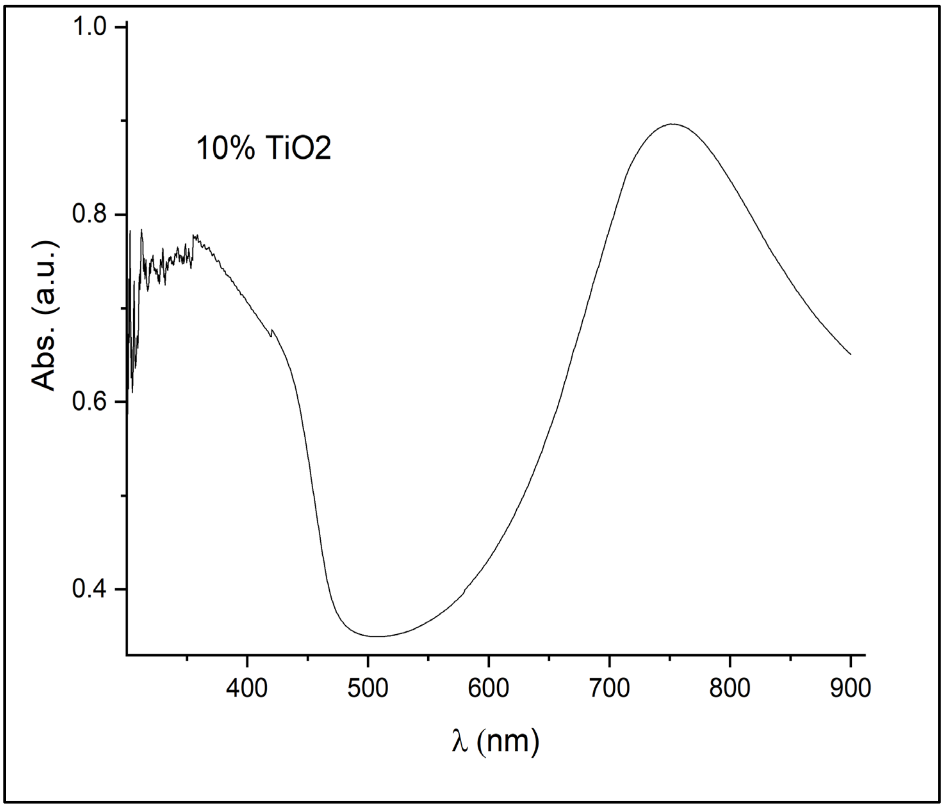


Figure 3. UV–Vis absorbance spectra of pristine PAni and PAni–TiO2 nanocomposite.

Conclusions

In conclusion, the in-situ polymerization process was used to successfully synthesize PANI/TiO2 nanocomposites containing five different weight percentages of TiO2 NPs. By using UV-VIS spectroscopy, scanning electron microscopy SEM, and energy dispersive X-ray spectroscopy EDX, we were able to demonstrate the existence of PANI and TiO2 NPs in the nanocomposite materials.

The results reveal unequivocally that the composite films have excellent optical characteristics, as expected. Increased TiO2 content in the polymer matrix resulted in a rise in the optical absorption, which was noticed as the TiO2 level increased.

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