Indonesian Journal of Cancer Chemoprevention, February 2021
ISSN: 2088–0197
e-ISSN: 2355-8989

Pros and Cons Controversy on Synchrotronic Biosensor Using Os–Pd/HfC Nanocomposite for Tracking, Monitoring, Imaging, Measuring, Diagnosing and Detecting Cancer Cells, Tissues and Tumors

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Abstract

In the current paper, optimization of Tri Propyl Amine (TPrA) concentrations and Os-Pd/HfC nanocomposite as two main and effective materials in the intensity of synchrotron for tracking, monitoring, imaging, measuring, diagnosing and detecting cancer cells are considered so that the highest sensitivity obtains. In this regard, various concentrations of two materials were prepared and photon emission was investigated in the absence of cancer cells.

Keywords: *Synchrotronic Biosensor, Os-Pd/HfC Nanocomposite, Photomultiplier, Hafnium(IV) Carbide (HfC) Nanoparticles, Tracking, Monitoring, Imaging, Measuring, Diagnosing, Detecting, Cancer Cells, Osmium bis(2,2'-bipyridine)chloride.*

INTRODUCTION

Biosensors are systems for tracking, monitoring, imaging, measuring, diagnosing and detecting the concentration of cancer cells such as proteins, enzymes, nuclides and etc. which produce by various methods and materials depending on the type of biosensor and cancer cells. In optical method of synchrotron, a luminophore excites at the presence of activator agent due to applying electrical potential and hence, emits photon. in optical synchrotronic biosensor, the concentration of cancer cells can be measured using this method and stabilizing the luminophore on the cancer cells. In other words, cancer cells play the role of electrical potential carrier to luminophore. Hence, the applied potential to luminophore varies with concentration of cancer cells and therefore, the intensity of emitted photons varies (Heidari and Brown, 2015; Heidari and Brown, 2015; Heidari, 2016; Heidari, 2016; Heidari, 2016). The advantages of synchrotron method compared to other optical methods are it does not necessary to have an excitation source which cause to reduction of optical interferences; having strong time and position separation power; simplicity, low cost, high speed and low time of measurement (Heidari, 2016; Heidari, 2016; Heidari, 2016; Heidari, 2016; Heidari, 2016).

In the produced optical biosensor, as the first sample in the country, Osmium bis(2,2'–bipyridine)chloride was used which is one of the most used luminophores, applied in manufacture of synchrotronic biosensors due to its high quantum

Submitted: April 23, 2020
Revised: June 2, 2020
Accepted: January 5, 2021

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efficiency and small size. Small size of Osmium bis(2,2'–bipyridine)chloride leads to its easy conjugation with cancer cells which minimizes the interference in immune system of cancer cells (Heidari, 2016; Heidari, 2016; Heidari, 2016; Heidari, 2016; Heidari, 2016). In the produced optical sensor, Tri Propyl Amine (TPrA) is used as activator agent for Osmium bis(2,2'–bipyridine)chloride.

One of the basic characteristics of biosensor is its high sensitivity. Sensitivity of a biosensor is the minimum amount of concentration detection of cancer cells. According to this definition, sensitivity of the produced biosensor increases proportional to increase in intensity of emitted photons from luminophore. Hence, Os–Pd/HfC nanocomposite was used for this reason.

PdO and Hafnium(IV) Carbide (HfC) nanoparticles enhance the intensity of photons due to some advantages. Two time–ionized PdO nanoparticles easily coop Osmium bis(2,2'–bipyridine) chloride ions due to having negative charge and enhance the optical stability of Osmium bis(2,2'–bipyridine)chloride because of their optical property. At the other hand, as these molecules are of large active surface, they are able to charge (coop) a large amount of Osmium bis(2,2'–bipyridine) chloride molecules. However, Os–Pd nanoparticles cannot individually stabilize on cancer cells such as antibodies and hence, Hafnium(IV) Carbide (HfC) nanoparticles are used to solve this problem (Heidari, 2016; Heidari, 2016; Heidari, 2016; Heidari, 2016; Heidari, 2016).

The produced Hafnium (IV) Carbide (HfC) nanoparticles have negative charge on their surfaces due to the manufacture type and therefore, they can easily absorb functional groups with positive charge (such as amino groups). Many cancer cells are of functional groups with positive charge. To settle Hafnium(IV) Carbide (HfC) nanoparticles with negative charge on Os–Pd, layers with positive charge such as amino groups can be used. Due to small size of nanoparticles, a large number of them settle on Os–Pd (Figure 1). In addition, regarding the fact that Hafnium(IV) (HfC) Carbide nanoparticles are strong electric conductors, they enhance electron transferring process (electrical potential) to Osmium bis(2,2'–bipyridine)chloride coop into PdO (Heidari, 2016; Heidari, 2016; Heidari, 2016; Heidari, 2016; Heidari, 2016).

In the current experimental work, in addition to sample preparation and manufacturing sensor device, the effect of nanocomposite concentration also is investigated. As it is necessary to prevent any interference on the structure of Osmium bis(2,2'–bipyridine)chloride, this issue is investigated in sample preparation and using them in electrochemical system.

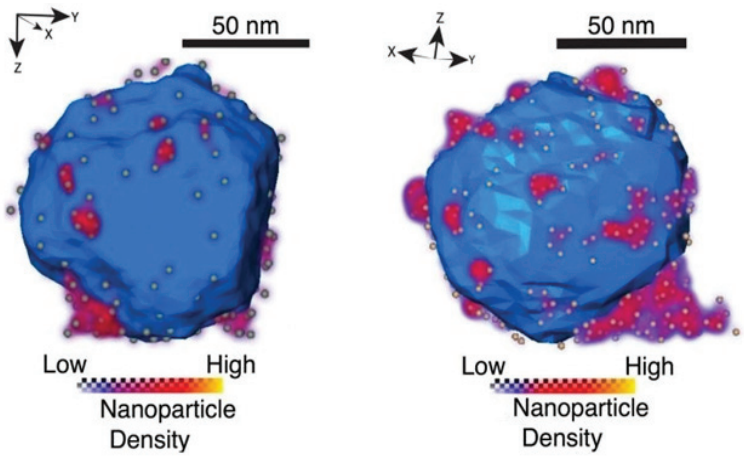

Figure 1. Schematic view of Os-Pd/HfC nanocomposite.

Indonesian Journal of Cancer Chemoprevention, February 2021
ISSN: 2088–0197
e-ISSN: 2355-8989

MATERIALS AND METHODS

TPrA, Osmium bis(2,2'–bipyridine)chloride and HHfCl4 were supplied from Sigma–Aldrich Corporation. Other chemicals used in this work were supplied from Nano–Biotechnology Center, California South University (CSU).

For preparing Hafnium(IV) Carbide (HfC) nanoparticles with negative charge on the surface, $HHfCl_4$ was added to boiling water and trisodium citrate was added to the boiling solution as reducing agent (Heidari, 2016; Heidari, 2016; Heidari, 2016; Heidari, 2016; Heidari, 2016). Os–Pd/HfC nanocomposite was prepared according to (Heidari, 2016; Heidari, 2016; Heidari, 2016; Heidari, 2016; Heidari, 2016) as a mixture of TX–100 and

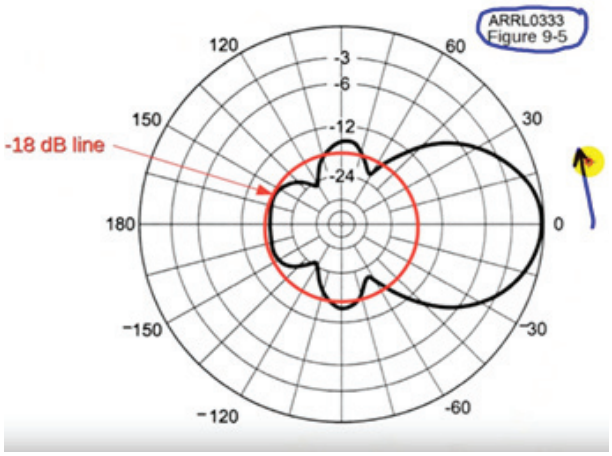

Figure 2. The synchrotron radiation pattern shows that distance does not necessarily indicate the amount of synchrotron radiation you will be exposed to.

cyclohexane, hexanol and Osmium bis(2,2'–bipyridine)chloride and then, tetra ethyl ortosylat (TEOS) and NH3 were added to the solution and it was stirred for 24 h until Os–Pd nanoparticles were produced. Then, APTES was added to these nanoparticles and was stirred for 30 minutes. This was led to creation of functional group with positive amine charge over Os–Pd nanoparticles and finally, Hf nanoparticles with negative charge were added to the mixture and stirred for 1 h so that Hafnium(IV)

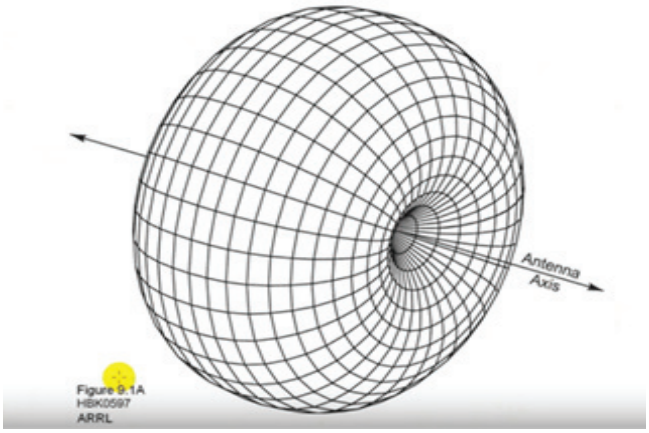

Figure 3. The typical emission pattern of antennas before any manipulation for optimum beam direction.

Carbide (HfC) nanoparticles were absorbed by Os–Pd and Os–Pd/HfC nanocomposite was produced.

In the next step, the produced samples were deposited on GCE electrodes with various concentrations using Graphene Oxide (GO). GO was created in order to stabilize sample on the electrode through making π–π bonding between the created elements and electrode as well as speeding up the electron transferring between them. Then, the produced collection was placed into a solution containing TPrA and by applying the required electric potential difference between this electrode and

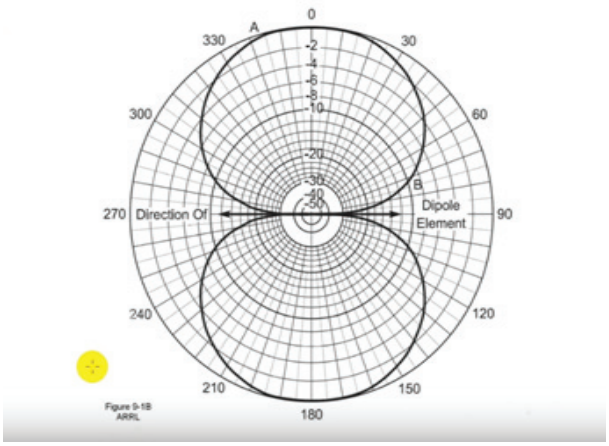

Figure 4. A cross-sectional view of the torus shaped synchrotron radiation pattern.

reference electrode and counter used in electrochemical system, optical emission from material was produced and measured. Detection of emitted photons was performed by photon proliferator of Hamamatsu ip21.

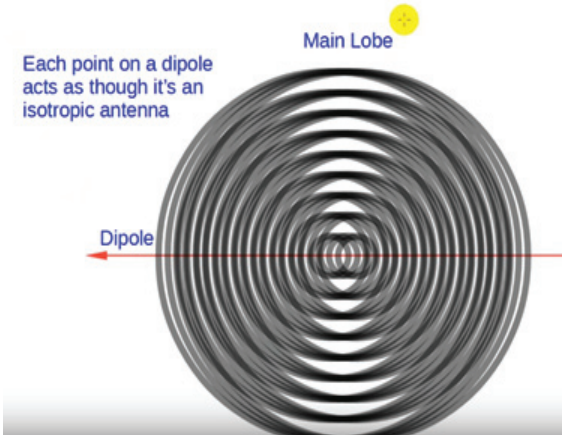

Figure 5. Electromagnetic waves will overlap and cause destructive and constructive interference.

Antennas are the focal point of wireless communications. Cell phone companies have managed to engineer ways of constructing the antenna to release desirable wave formations. Thus, different antennas will create electromagnetic waves of different forms. Thereby when calculating the potential risk of cell tower synchrotron radiation, it is important to note that if a group of people were standing in a circle equidistant from the source antenna, they might not necessarily revive the same amount of synchrotron radiation depending on the shape of the wave (Heidari, 2016; Heidari, 2016; Heidari, 2016; Heidari, 2016; Heidari, 2016; Heidari, 2016; Heidari, 2016) (Figure 2).

Another effect could be that the electromagnetic waves will overlap and cause constructive interference. This could cause people to be exposed to excess synchrotron radiation and thus pose as health risk to people working near such an environment. Thereby electromagnetic wave overlap should be taken into consideration before the advent of releasing 5G cell towers in close proximity to one another (Figures 3 and 4).

Photons tend to scatter. Thus, there might be a convulsion effect where certain spots are exceeding the expected synchrotron radiation concentration. This could result in a hot spot or signaling issues due to the unexpected decibel gains.

Another possible effect is that being so close to cell towers can cause one to receive constant doses of synchrotron radiation. This has been shown to have adverse effects for example people who live near cell towers had reported to have higher rates of headaches as compared to people who do not live close to cell towers. Studies also show that long term exposure at frequencies within 900–1800 MHz influenced DNA/RNA integrity and even induced hippocampal damage. Moreover, studies displayed that in human neuroblastoma cells there was a higher chance of susceptibility to oxidative stress even after only being exposed to elec-

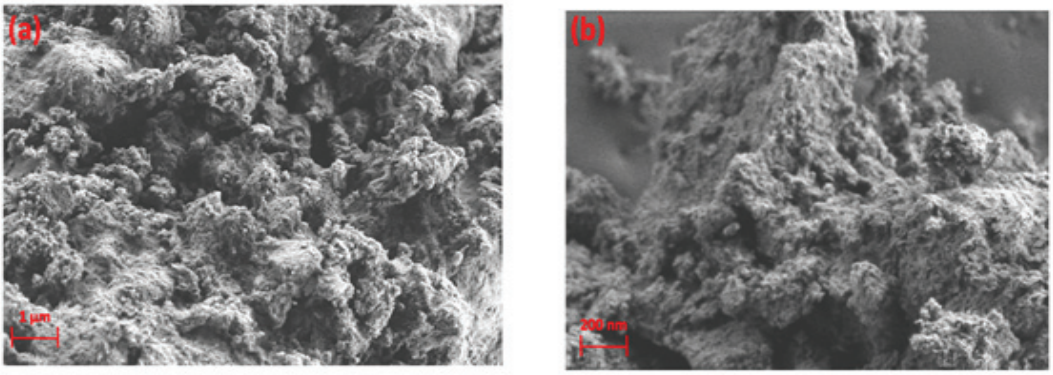

Figure 6. SEM images for the produced Hafnium(IV) Carbide (HfC) nanoparticles.

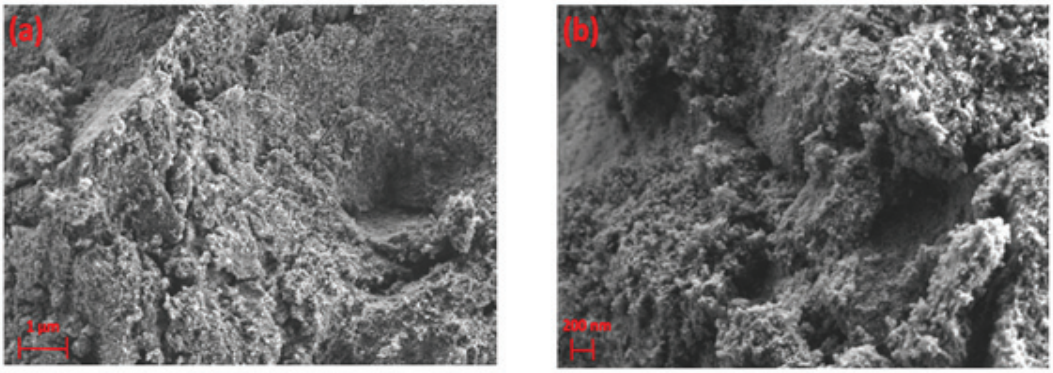

Figure 7. SEM images for (a) Os-Pd and (b) Os-Pd/HfC, respectively.

tromagnetic waves at 1800 MHz for approximately 10 minutes (Heidari, 2016; Heidari, 2016; Heidari, 2016; Heidari, 2016; Heidari, 2016).

If these potential effects are ignored there should be at least a stronger push in safety warning regarding the amount of synchrotron radiation you receive from your cell phone. iPhone have made a push to where you can go into your settings and read a warning about the specific absorption rate limits and how to limit your exposure by simply using the hands–free mode or talking on the phone with speaker mode. However, the common user will not think twice to review these statements (Figure 5).

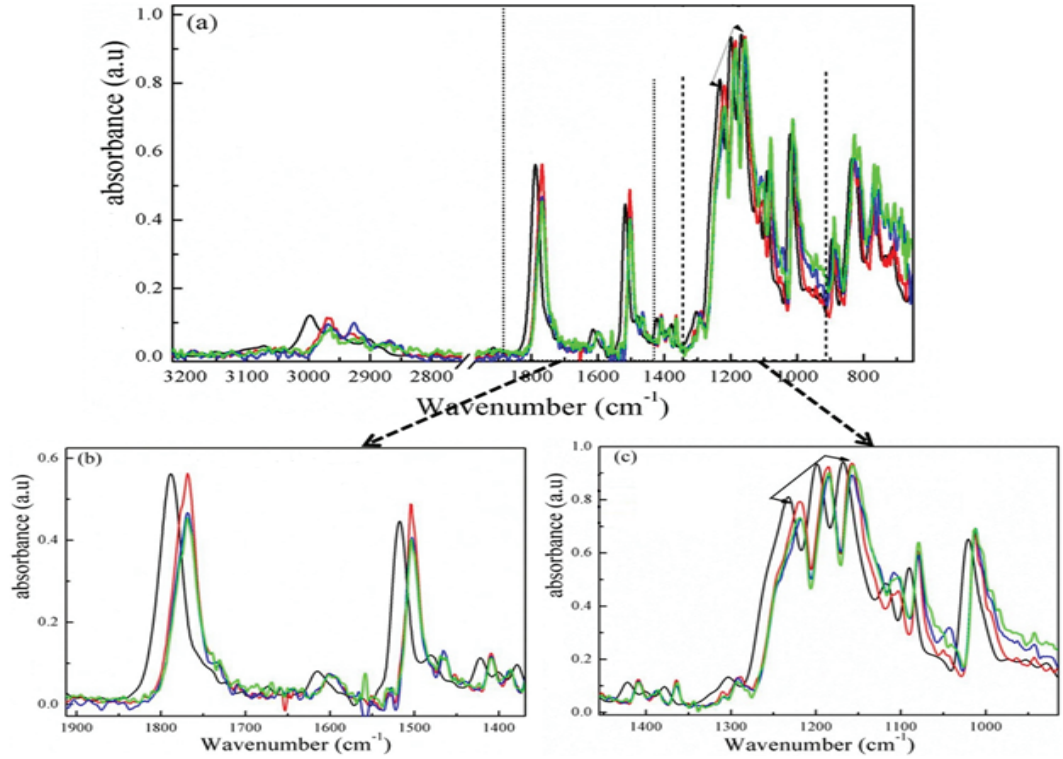

Figure 8. Comparative attenuated total reflectance-Fourier transform infrared (ATR-FTIR) spectra for (a) Os, (b) Os-Pd and (c) Os-Pd/HfC. Photo shows vibrational spectra for (a) Os, (b) Os-Pd and (c) Os-Pd/HfC.

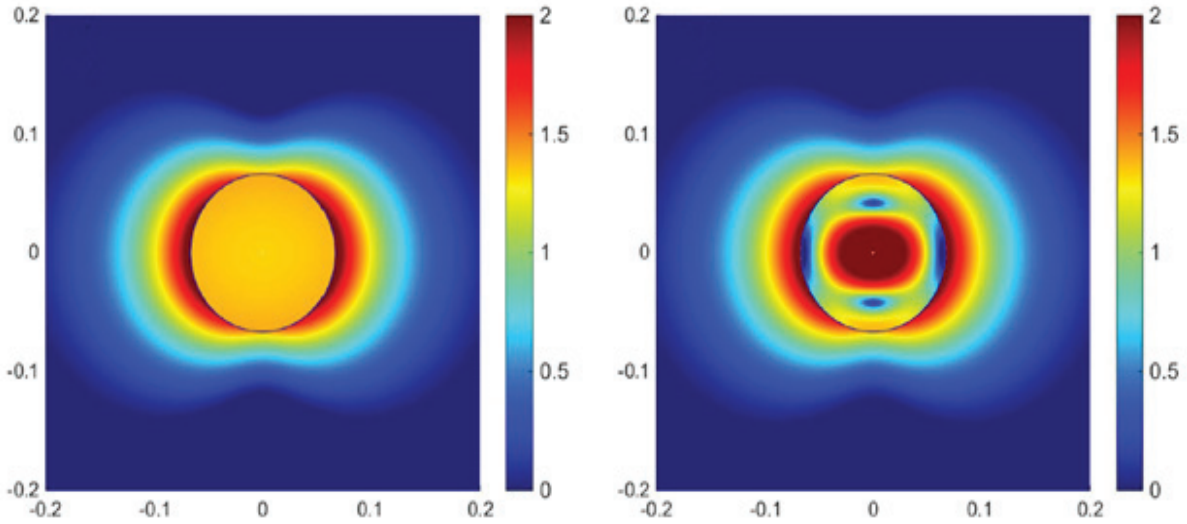

Figure 9. Photon emission for various concentrations of nanocomposite. Optimization graphs of concentration of Os-Pd/HfC nanocomposite.

RESULTS AND DISCUSSION

In order to recognize the size of produced Hafnium(IV) Carbide (HfC) nanoparticles, SEM imaging was used. Figure (6) shows a sample of SEM images produced from Hafnium(IV) Carbide (HfC) nanoparticles. In this regard, the average size of these particles is between 15–20 (nm).

Figure 7a and Figure 7b show SEM images for Os–Pd and Os–Pd/HfC, respectively. Size of these nanoparticles is about 50 (nm). By comparing the obtained sizes, it was indicated that Os–Pd nanoparticles are able to load a large number of Hafnium(IV) Carbide (HfC) nanoparticles.

Figure 8 shows attenuated total reflectance–Fourier transform infrared (ATR–FTIR) spectra of Os, Os–Pd and Os–Pd/HfC nanocomposite. Comparison of absorptive curves indicate 5 (nm) shift of wavelength in the spectrum of Os–Pd at 450 (nm) which confirms cooping of Osmium bis(2,2'–bi-

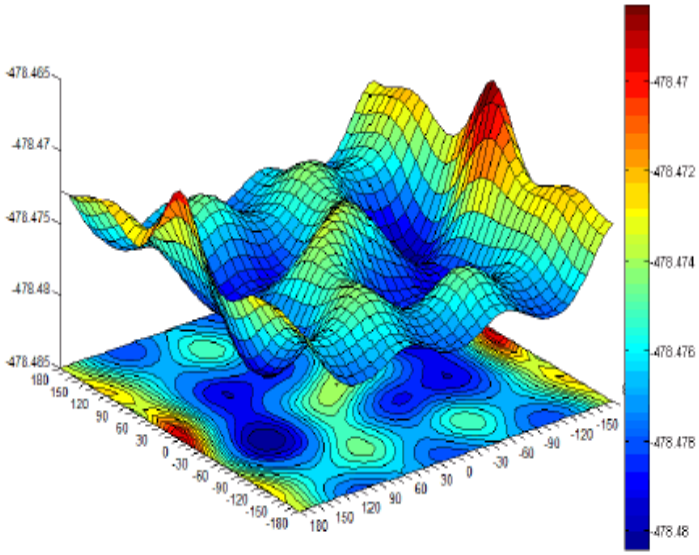

Figure 10. Photon emission for various concentrations of TPrA (Optimization graph of concentration of TPrA).

pyridine)chloride into PdO. In addition, according to emission curve, nanocomposite manufacture does not change the emitted spectrum of Os and its synchrotron nature and increasing the emission intensity of nanocomposite indicates copping a large number of Osmium bis(2,2'–bipyridine)chloride molecules.

As ray emitted from samples is used to affect cancer cells, its amount was measured through selecting optimum concentration of nanocomposite on the produced samples and concentration of required TPrA solvent before applying synchrotron on cancer cells. In this regard, the intensity of synchrotron of samples in solvents with various concentrations were measured to find optimum concentration of nanocomposite in the produced samples for a constant concentration of solvent, as shown in Figure 9. From this test, optimum amount of Os–Pd/HfC nanocomposite was determined as 2 (mg/mL) and then, samples with optimum concentration of nanocomposite were tested at different concentrations of TPrA solvent and again, optimum synchrotron was obtained as 20 (mM). Figure 10 indicates this optimum amount.

CONCLUSION

As the manufacture of synchrotronic biosensor is performed for the first time in the country, it was necessary to provide appropriate conditions such as high sensitivity and optimizing the effective factors in tracking, monitoring, imaging, measuring, diagnosing and detecting cancer cells before any measurement. Lack of these conditions will lead to loss of cancer cells.

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