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High Power Discharge Lamps and Their Photochemical Applications: An Evaluation of Pulsed Radiation

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1. Introduction

The photochemical applications of the ultraviolet (UV) radiation develop with rate accelerated so much in the field of general public technologies as in lighting, descriptive, and imagery, and too of the advanced technologies (treatment and engraving of surfaces, air, water and agro-alimentary treatment). The radiation sources used are generally high, medium and low pressure gas discharge lamps.

In the past decades, gas discharge lamps have gained widespread use in industrial applications. Due to their unique design properties concerning spectral, electrical and geometrical features, all types of gas discharge lamps can been found in technical applications. Mercury based lamps are the workhorses in many applications upgraded by their relatives, the metal halide versions. The low and medium pressure mercury lamps are usually used as sources of UV radiation. Low pressure mercury lamps are used extensively for disinfection of drinking water, packing material and air. Medium pressure lamps are applied in printing industry to dry inks and cure adhesives, in waste water treatment plants to reduce the total organic compounds (TOC) and as a competing technology to low pressure versions in germicidal applications. Metal halide doped versions of medium and high pressure mercury lamps open the possibility to adjust spectral output to specific requirements.

The control of the spectral distribution of energy is considered as the main parameter affecting the system flexibility and the product quality. However, even though the lamp characteristics have an important impact on the spectral distribution of radiation, the power supply characteristics cannot be neglected. Indeed, the temporal characteristics of the system are controlled mainly by the used power supply.

Indeed, in the case of the high pressure lamps, the significant interactions between particles, it is difficult, with traditional power supply (electromagnetic ballasts) to move the energy distribution of the electronic cloud compared to Local Thermodynamic Equilibrium (LTE). However, by using short pulses of current one can hope to obtain such a result and to modify of this fact the distribution of the atomic excitation and the spectral distribution of the radiation (mainly visible and ultraviolet). Former works showed that the form of the current wave imposed on the lamp could be selected so as to improve the production of the radiation (Chalek, 1981; Brates, 1987; Chammam et al., 2005; Mrabet et al., 2006; Bouslimi et al., 2009a, 2009c). It remains, for these sources, to optimize the parameters of excitation (form, amplitude, frequency, duration of pulses) according to those of the discharge (natural of the mixture gas, energy spectral distribution).

Current UV radiation technology is dominated by two techniques, the continuous radiation and pulsed-radiation. The first technique provides a lower-level constant-flux UV radiation. The second technique provides radiation doses through flashing a source lamp. The effect of this pulsing technique is to provide short pulses of higher energy into the system.

The technology of the electronic pulsed supply is a field of studies relatively new related to the development of the generators, switches and electric applications of high energy, with weak durations and face of fast rise. These pulsed operations created by current or voltage pulses produce a pulsed light rich in UV.

The pulsed light system rich in UV radiation from 100 to 400 nm seems to be a promising alternative for the decontamination of the foodstuffs, and the sterilization of packing. Its effectiveness is now fully proven in experiments for decontamination on the surface of the products. Recent studies show the effectiveness of this treatment on products in powder form in fine layer. Bacteria in vegetative form, the ascosporous of moulds, the viruses and the parasites are destroyed by this instantaneous contribution of energy. Many works was completed on the biological effects of the UV carried out an excellent bibliographical analysis on this subject (Mimouni, 2004; Dunn et al., 1997a, 1997b; Dunn et al., 1990; Jagger, 1967; Fine, 2004).

The UV radiation as a disinfection technique has been also proven in multiple industrial applications, especially in the water treatment. Applications for water UV treatment are numerous: Potabilization of water, waste water treatment, treatment of seawater for aquaculture and shellfish culture. An historic perspective on UV disinfection has been published in several review articles (Groocock, 1984; Schenck, 1981; USEPA, 1996; Wolfe, 1990; Zoeteman et al., 1982).

The general objective of this work consists in studying the effect of the current pulses, provided by a feeding system (prototype) designed in our laboratory, on the spectral radiant flux emitted by two types of lamps: high and medium pressure mercury vapour lamps. The first is used mainly for screen printing, copying, and light curing adhesives and varnishes, and the second is germicidal gas-discharge lamps, intended particularly for water treatment. The spectral results obtained by two mode of current, highlight and evaluate the effectiveness of the pulsed current on the radiation production in the ultraviolet and the visible part of the spectrum.

In the remainder of this chapter, we present in the second section an overview of the ultraviolet applications. In the third section, we explore some special lamps for technical applications and their power suppliers. The experimental results of time-dependent electrical and spectral measurements carried out on high and medium pressure mercury lamps operated in pulsed current, are compared with the square wave operation for the same consumption in section 4. The paper is finally summarized with some conclusions in section 5.

2. Overview of UV-lamp applications

2.1 Ultraviolet radiation

Like visible light, Ultraviolet light (UV) is a classification of electromagnetic radiation having a wavelength bandwidth between 100 and 400nm, between the X-ray portion of the spectrum and the visible portion (Fig. 1). UV radiation is subdivided into four wavebands, which we use for a wide range of applications. These four subgroups within the UV spectrum are located in the 100nm - 380nm waveband (Meulemans, 1986):

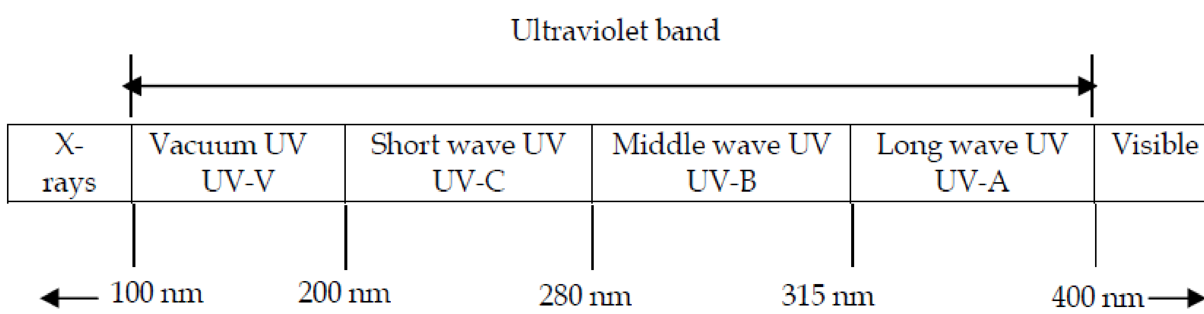

Fig. 1. Ultraviolet bandwidth

UV lamp TL 55W UV lamp TL-30 Watts 12 tubes UV lamp

Fig. 2. Ultraviolet lamps for water disinfection

- UVA (380-315nm) is used for curing UV adhesives and plastics. It is also used for fluorescent inspection purposes.
- UVB (315-280nm) is the most energetic region of natural sunlight and is used in conjunction with UVA light for artificial accelerated aging of materials.
- UVC (280-200nm) is used for rapid drying of UV inks and lacquers. It is also used for sterilization of surfaces, air and water
- VUV (vacuum-UV, 200-100nm) can only be used in a vacuum and is therefore of minor importance.

Practical application of UV disinfection relies on the germicidal ability of UVC and UVB and depends on artificial sources of UV. The most common sources of UV are commercially available low and medium pressure mercury arc lamps (Fig. 2).

2.2 UV applications in photochemistry

Photochemistry is the study of the action of light on chemical reactions. In a more precise, it includes works whose purpose is to determine the nature of the reactive excited states of molecules obtained by absorption of light, to study the deactivation process of these states, especially those that lead to products different reagents and irradiated to establish the mechanisms by which rearrangements occurring intra-and intermolecular initiated by radiation (Hecht, 1920).

The chemical reactions induced by light indirectly as a result of electronic energy transfer are an area of study and implementation has long been known (F. Weigert, 1907) and highly developed now. In general, photo-chemical processes are part of different modes of deactivation of molecules previously made in their metastable excited states by absorption of a photon.

Ideally, a photochemical process is performed by irradiating the sample with monochromatic light, since the reaction may depend on the excitation wavelength. Most of polychromatic light sources; the wavelength is selected or required by filters or by a monochromator (Hecht, 1920). Light sources are now almost always discharge tubes containing either xenon or mercury vapor alone or in carefully selected impurities. Some of these lamps are very powerful and they can consume tens of kilowatts of electricity.

The first application of photochemistry was the isomerization of benzene in the liquid state: Under the influence of radiation from a mercury vapor lamp (253.7 nm), the isomerization of benzene in liquid product benzvalene and fulvene, while in the field of wavelength range 166-200 nm, irradiation produces more benzene told Dewar (Fig.3).

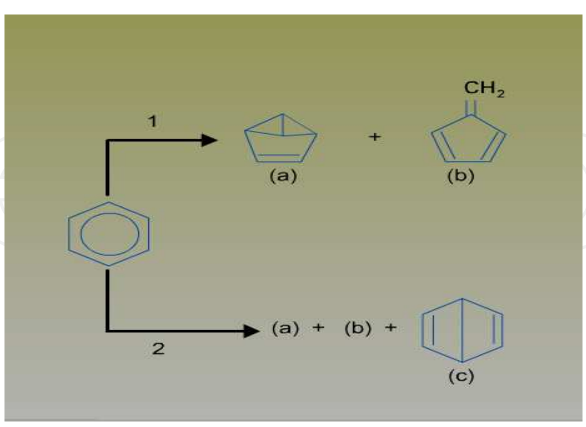

Fig. 3. Isomerization of benzene in liquid

Today industrial, photochemistry has made its biggest breakthrough in the field of setting polymers on different surfaces, such as the "drying" of printing inks and the manufacture of electronic circuits. The notion of quantum efficiency is very important in photochemistry. For that performance is great each application needs a specific wavelength. Although its optimal wavelengths are known. We find that the sources most frequently used are medium pressure mercury lamps (possibly doped with iron iodide) and xenon lamps.

Photochemistry is also used in the curing (polymerization) of specially formulated printing inks and coatings. Since it was originally introduced in the 1960's, UV curing has been widely adopted in many industries including automotive, telecommunications, electronics, graphic arts, converting and metal, glass and plastic decorating.

Ultraviolet curing (commonly known as UV curing) is a photochemical process in which high-intensity ultraviolet light is used to instantly cure or “dry” inks, coatings or adhesives. Offering many advantages over traditional drying methods; UV curing has been shown to increase production speed, reduce reject rates, improve scratch and solvent resistance, and facilitate superior bonding.

Using light instead of heat, the UV curing process is based on a photochemical reaction. Liquid monomers and oligomers are mixed with a small percent of photoinitiators, and then exposed to UV energy. In a few seconds, the products - inks, coatings or adhesives instantly harden.

UV curable inks and coatings were first used as a better alternative to solvent-based products. Conventional heat- and air-drying works by solvent evaporation. This process shrinks the initial application of coatings by more than 50% and creates environmental pollutants. In UV curing, there is no solvent to evaporate, no environmental pollutants, no loss of coating thickness, and no loss of volume. This results in higher productivity in less time, with a reduction in waste, energy use and pollutant emissions.

UV-VIS spectroscopy is one of the main applications of photochemistry. It allows us to determine the concentration of a molecule in a sample, and sometimes, it can aid in identifying an unknown molecule. The molecule being tested must absorb light in the ultraviolet (about 200 to 400nm) or the visible (about 400 to 700nm) range in order to be detected by this equipment. A light beam containing multiple wavelengths gets passed through a small container holding your sample, and the computer records which wavelength(s) were absorbed, and at which intensity.

Another emerging UV application is the photocatalysis. This is the photoactivation of a surface covered with TiO_2 (sometimes doped) which is causing a hyper-hydrophilicity.This process leads us to make self-cleaning surfaces using the following procedure in figure 4.

Usually, this type of process uses UV-C (<180 nm). Xenon lamps with low-pressure radiation at 172nm are well positioned for this application. However, today by doping the layer of TiO_2, we get a photoactivatable produce materials with wavelengths larger located in the UV-A (380 nm). Lamps or dielectric barrier to Xe_2 or Xe-halide combinations seem to be the most promising sources.

2.3 Mechanism of UV disinfection

The UV disinfection process corresponds to the inactivation of microorganisms, following a modification of their genetic information: the UV affect the DNA double helix, as well as RNA, cells, blocking all biochemical processes used for their reproduction. The maximum efficiency of UV disinfection depends on the energy emitted (with peaks near 200 and

260nm), more precisely; it corresponds to output energy of 253.7 nm (absorption peak of UV radiation by micro-organisms) (Wright & Cairns, 1998; Sonntag et al., 1992).

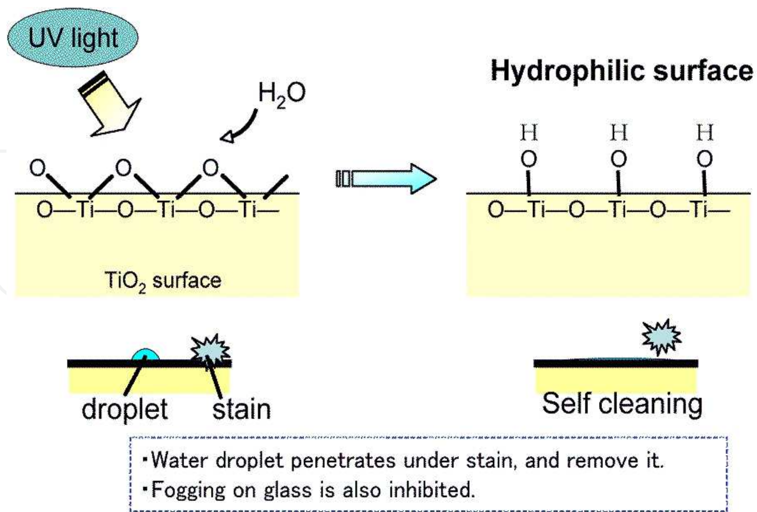

Fig. 4. The process of self-cleaning surfaces

Absorbed UV promotes the formation of bonds between adjacent nucleotides, creating double molecules or dimmers (Jagger, 1967). While the formation of thymine-thymine dimers are the most common, cytosine-cytosine, cytosine-thymine, and uracil dimerization also occur. Formation of a sufficient number of dimmers within a microbe prevents it from replicating its DNA and RNA, thereby preventing it from reproducing. Due to the wavelength dependence of DNA UV absorption, UV inactivation of microbes is also a function of wavelength. Figure 5 presents the germicidal action spectra for the UV

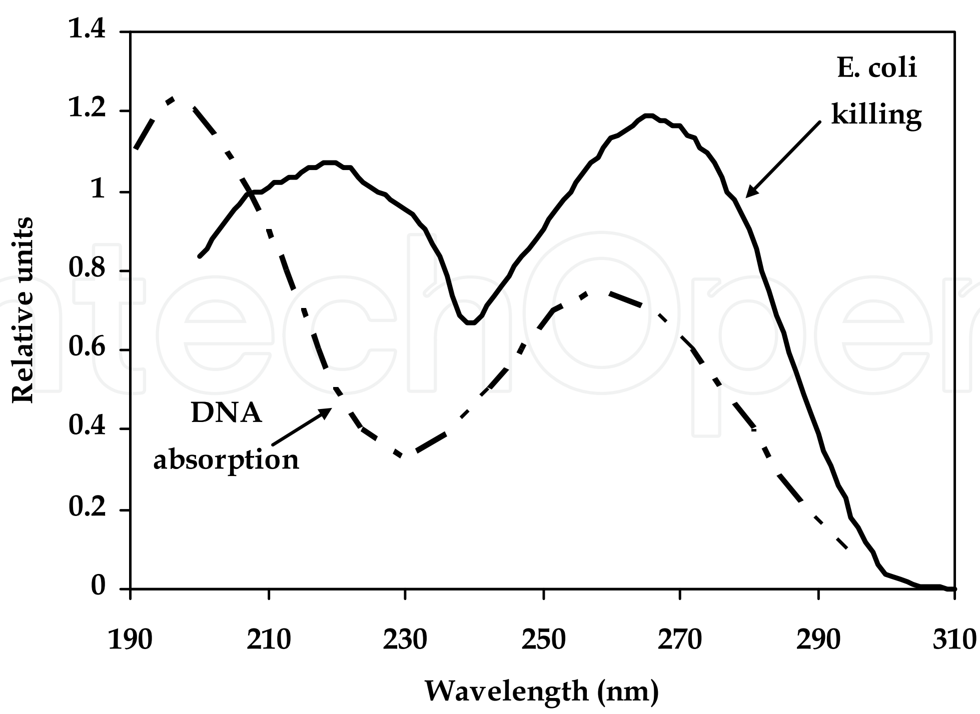

Fig. 5. Comparison of the action spectrum for E. coli inactivation to the absorption spectrum of nucleic acids (Wright & Cairns, 1998)

inactivation of E. coli. The action spectra of E. coli peaks at wavelengths near 265nm and near 220nm. It is convenient that the 254nm output of a low pressure lamp coincides well with the inactivation peak near 265nm (Wright & Cairns, 1998).

2.4 Biological effects of UV radiation

The effects of ultraviolet radiation on living organisms are due to its photochemical action. The best known are the erythema or "sunburn", for which the area of activity is between 320 and 280 nm (with a maximum at 297 nm), and "tan", which involves training, migration and oxidation of melanin, and whose field of activity is wider towards longer wavelengths, which allows you to tan without the risk of rash using products such as filters stopping the radiation of shorter lengths waveform.

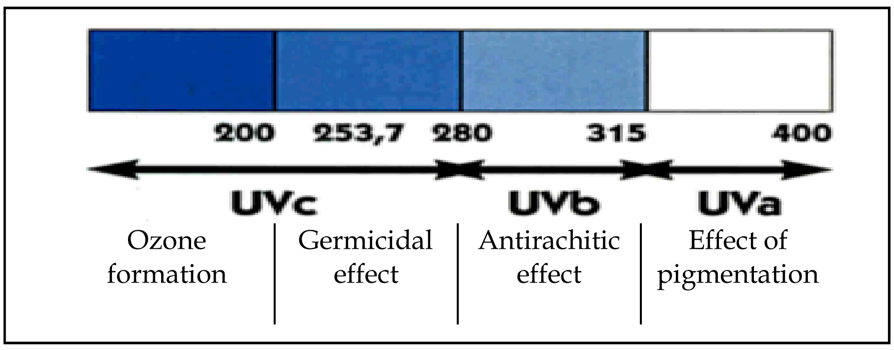

Fig. 6. UV-region spectrum of Sun

In terms of medical treatment, in addition to its use in some diseases of the skin, ultraviolet was mainly used for the treatment of rachitis; its action has the effect of the conversion of vitamin D sterols: direct radiation (sterols present in the skin), irradiation of food containing these elements, or for the direct synthesis of vitamin D.

As for dermatological applications in the fight against diseases such as vitiligo and psoriasis, there are two types of treatment. The first consists in irradiating the skin with a UV-A radiation at 308 nm, which inhibits locally the patient's immune system by calming for period more or less limited effects of the disease. For this application, dermatologists now use lasers. However, dielectric barrier lamps using a mixture of Xe-Cl2 begin to appear. The advantages of systems using these lamps are numerous: they are easy to handle, they require less maintenance, they are lighter and can be portable, compared to a laser. They produce a lower UV power and thus limit the risk of burns. The second method of treatment is called "PUVA". PUVA therapy is a method that combines a photosensitizing drug (in the series of psoralen) administered orally and irradiation of the skin lesions to be treated by long ultraviolet (UVA). The comparison of the effectiveness of each of psoralens used does not show clear-cut superiority of one or the other of them. Their general tolerance appears to be satisfactory, except for minor digestive problems. The tolerances are checked blood and liver in each case respectively by the blood counts, blood count and assay of transaminases. Elevated levels of these enzymes involves discontinuation of treatment is followed by a rapid normalization. It has been shown that the presence of radiation, psoralens are all capable of combining with the pyrimidine bases of DNA chains. This can lead to very different metabolic changes, which would explain why the PUVA appears to have contradictory effects. However, it might be a good alternative to chemotherapy against some types of skin cancer because UV radiations associated with psoralens have the power to destroy the offending cells.

The effects of UV on microorganisms depend on the doses, ranging from the reduction of vital processes (cell division, cell motility, synthesis of nucleic acid) to the destruction of organisms. The germicidal action, observed during exposure to UVC radiation type, is most effective when the wavelength is between 250 and 260 nm (253.7 nm). At this level, the UVC damage the nucleic acids of microorganisms, causing the amount of energy following implementation (afigfoessel.fr):

- A bacteriostatic effect in the case of low radiation level of the cell. In this case it continues to live while unable to reproduce.
- A bactericidal effect in the case of a significant radiation at the cellular level. In this case it is destroyed.

The germicidal action has received applications where mercury vapour lamps are used (253.7 nm): surface sterilization of food products or pharmaceuticals in their packaging, disinfection of objects, air and water (difficult because of the absorption if the water is not pure).

Today we do not really know the answer of microorganisms to UV radiation, but, empirically, we know what is the ultraviolet dose required to kill different microorganisms to a certain percentage (usually for the treatment of water, this is between 90 and 99%).

For water treatment (potable and tertiary) where the rate of destruction of microorganisms required no more than 2log (99%), now the most commonly lamps used are UV lamps, low pressure (using amalgam thereby obtaining high power of about 100 W / lamp) and HID lamps "medium pressure" (pure mercury lamps with power ratings up to 5 kW, see more in some cases). Some systems based on the phenomenon of photo-catalysis are emerging in the market. Regardless of the application cited above photo-biological lamps used do not produce the optimal wavelength.

2.5 Other UV applications

The following table summarizes some other UV wavelength applications "optimal"

Xe2 (172 nm)	**KrCl (222 nm)**	**XeBr (282 nm)**
▪ Cleaning of surfaces ▪ Photochemical vapour deposition ▪ Modification of structure and composition of surfaces ▪ Activation of surfaces ▪ UV matting ▪ Ozone generation	▪ Photolysis of to hydrogen peroxide ▪ Inactivation of microorganism ▪ UV curing for printing processes ▪ Photochemical vapour deposition	▪ Inactivation of microorganisms ▪ UV curing for printing processes

Table 1. Various UV wavelength applications

In view of that, practical application of UV disinfection depends on artificial sources of UV and their mode of electrical power supplier. The most common sources of UV are commercially available low and medium pressure mercury arc lamps. The power suppliers (named ballasts) for mostly lamps may be characterized as either electromagnetic or electronic ballasts (O'Brian et al., 1995; Phillips, 1983).

3. Lamps for technical applications and their power suppliers

In addition to low, medium and high pressure mercury discharge lamps, mercury short arc lamps with high operating pressures are found wherever high brightness and good imaging is required, for example in steppers for micro-lithography or as ultra-high pressure types in projectors. Besides the huge field of specialty lighting (stage-studio-TV, floodlights, effect-lighting and car headlights) with special focus on the response function of human eyes, these lamps are also used in reprographic machines, photo-chemistry, medical applications and by the tanning industry. Thus covering the whole field from pure industrial use to directly consumer related applications.

Pure rare gas fillings are used in flash-lamps for pumping the active medium of solid state lasers, whereas long arc xenon lamps satisfy the request for simulating solar radiation in chambers to test the radiation resistance of textiles and colours. Highly stable deuterium-lamps are operating in UV spectrometer and analytical instruments (HPLC, LC) as a source for broadband UV-radiation between 150 and 300nm.

In addition to the above mentioned lamp types, excimer lamps have gained increased interest during the last decade due to their quasi monochromatic spectrum. Intense and efficient UV generations of these lamps have revealed their potentials in the application field of surface modification, cleaning, curing and disinfection.

Discharge lamps are a source of light in which light is produced by the radiant energy generated from a gas discharge. A typical mercury arc lamp consists of a hermetically sealed tube of UV -transmitting vitreous silica or quartz with electrodes at both ends (Phillips, 1983). The tube is filled with a small amount of mercury and an inert gas, usually argon. Argon is present to aid lamp starting, extend electrode life, and reduce thermal losses. Argon does not contribute to the spectral output of the lamp. Most gas discharge lamps are operated in series with a current-limiting device. This auxiliary, commonly called ballast, limits the current to the value for which each lamp is designed. It also provides the required starting and operating voltages.

Ballasts are classified into two major types: electromagnetic ballasts and high-frequency electronic ballasts. The conventional ballast, made of a simple electromagnetic coil, has many significant disadvantages, such as large size, heavy weight, including low-frequency humming, low efficiency, poor power regulation, and high sensibility to voltage changes, etc. Since the electronic ballast can overcome these drawbacks. The high operating frequency allows to the ballast to be smaller and lighter-weight than the electromagnetic ballast. Unfortunately, there is a serious problem of acoustic resonance when the lamps operate in certain frequency range; this phenomenon is even severe for low-wattage lamps. These types of ballasts is more widely developed and used in many applications (Bouslimi et al., 2009b).

The structure of the electronic pulsed power supply developed in our laboratory presents several advantages in this domain. The main advantage of the proposed topology is to provide to the lamp a various shapes of current (square wave, rectangular and pulses) with optimization of the excitation parameter (form, amplitude, frequency, number and duration of pulses).

4. Experimental results

We present in this section, the effect of the current pulses, provided by the feeding system designed in our laboratory, on the ultraviolet and visible spectral flux emitted by two types of lamps: high and medium pressure mercury vapour lamps. In order to highlight and evaluate the effectiveness of the pulsed current on the radiation production, we give a comparison of spectral results obtained by two mode of excitation, rectangular and pulsed current.

4.1 Structure of the pulsed power supply

The bloc diagram of the lamp circuitry is shown in figure 7. The lamp is supplied mainly through an inverter connected with two electrical separate sources: the first source provides a rectangular wave current and the second provides a pulsed current.

The rectangular wave operation is achieved using a (DC) constant current source (S1) in conjunction with an electronic full bridge IGBTs inverter and an active protection system that allows protecting the IGBTs and the drivers against the over-voltage at the time of starting and the hot restarting of the lamp or by an unexpected opening of the circuit.

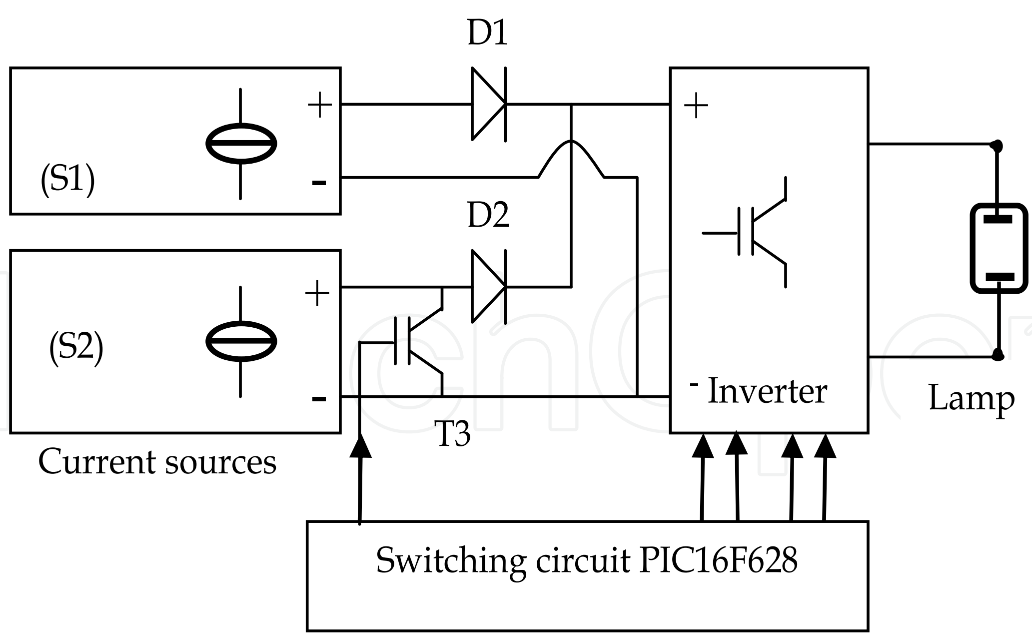

Fig. 7. Bloc diagram of the pulsed power supply

The pulsed operation is achieved by the second (DC) current source (S2) switched by a pulse switching circuit (transistor T3). The control signals for the pulse switching circuit and full wave bridge are ensured by a microcontroller (PIC16F628). The microcontroller provides flexibility in the integration of the two current source AC/DC converters with the full-bridge inverter. It allows obtaining a low-frequency rectangular wave with one or more pulses superimposed on each half cycle. The current in each source is controlled by a regulating circuit. D1 and D2 are anti-return fast diodes (Bouslimi et al., 2008, 2009a, 2009b).

This power supply allows as more studying the energy effectiveness and the photometric behaviour of various gas-discharge lamps (low, medium and high pressure), and this with an aim of evaluating the visible and ultraviolet radiation and of comparing it with the continuous radiation for the same consumption by the discharge lamps.

We also note that the proposed current pulsed power supply can be more exploited in photochemical applications exactly for the treatment of water whose needs a variation of the amplitude and the duration of the pulse (UV dose) according to the virus and bacteria lifespan (Severin et al, 1984). It cans also feeding power lamps going until 3kW.

4.2 The radiation produced by high pressure lamp in pulsed operation

4.2.1 Lamp characteristics

The main characteristics of filling, geometrical and electric of the discharge lamp used in this investigation are consigned in the table below.

Characteristics	Rating values
Diameter (mm)	18.2
Inter-electrode length (mm)	72
Total mercury mass (mg)	70
Argon pressure at the ambient temperature (torr)	10
Power (W)	400
I arc (A)	3.2
V arc (V)	140

Table 2. Characteristics of the studied lamp

The lamp operates vertically through a current inverter and all the measurements have been done in a steady state after the flux and circuit stabilization. Below, we present the results of our electrical and spectral measurements.

4.2.2 Spectral results (Bouslimi et al., 2009b)

Relative average spectral flux was recorded for a rectangular current and a pulsed current. In these two modes, the power provided to the lamp was the same one. Thus, it is possible to evaluate the influence of the current pulses on the radiation production effectiveness in the ultraviolet part and the visible part of the spectrum. Theses results are illustrated in figures 8 and 9.

If you look at the figures above we see that the difference between the spectral results for both modes of operation is small. Better to see the difference, we calculate the total flux through each band. The results for the average values of the total spectral flux determined from figure 8 and 9 above are summarised and given in Table 3.

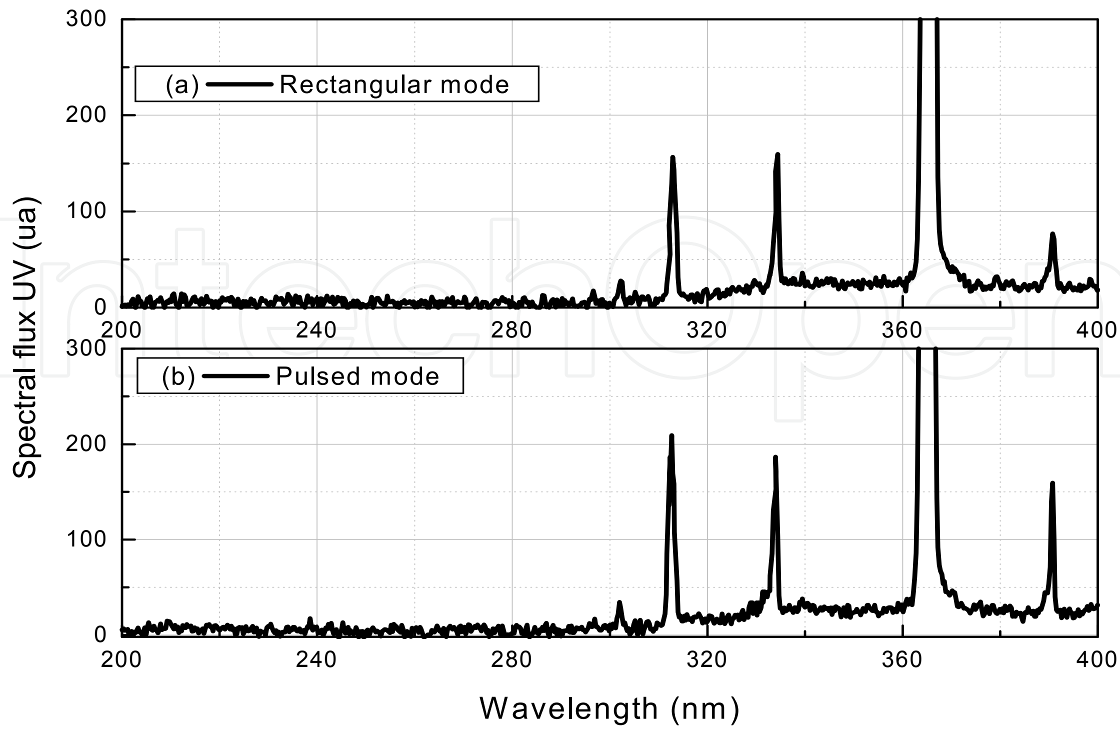

Fig. 8. Spectral flux UV with two supplying modes: (a) rectangular current; (b) with pulsed current

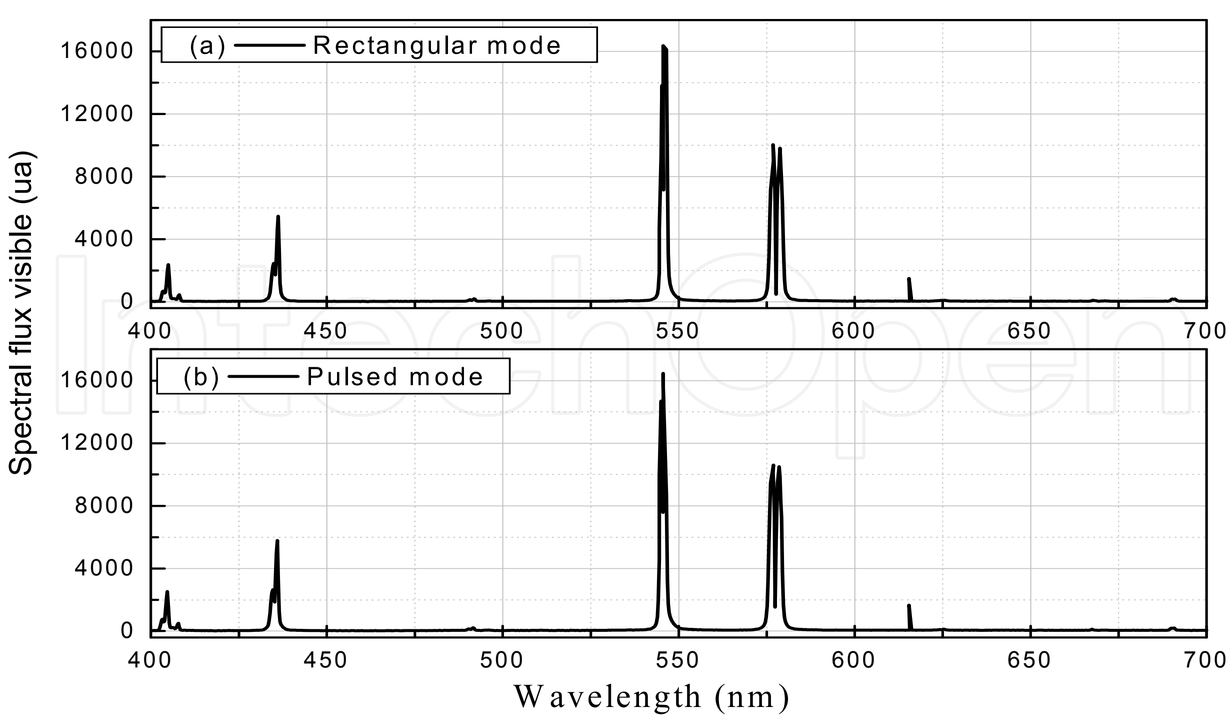

Fig. 9. Spectral flux visible with two supplying modes: (a) rectangular current; (b) with pulsed current

Spectral Bandwidth (nm)		total UV 200-400	Visible 400-700
Total flux (u.a)	Rectangular mode	4100	57512
	Pulsed mode (7 pulses per half period)	5510	60296
Relative progress (%)		34,4	4,84

Table 3. Comparison between the relative total flux of UV and visible radiation bands for two feeding modes of current: rectangular and pulsed

4.2.3 Discussion

We note a clear increase in all the lines measured in the pulsed mode for the same power as in rectangular mode. However, the increase is particularly marked in the ultraviolet band spectrum and limited to the visible (Table 3). We can say that the pulsed mode favors the short wavelengths emission (UV band). This increase is mainly due to rising temperatures in the pulsed mode.

The increase in the UV and visible radiation in pulsed mode compared to the rectangular is confirmed by the results found by (Chammam et al., 2005).

4.3 The radiation produced by medium pressure lamp in pulsed operation

In this part, we present experimental results (electric and spectral) for a medium pressure lamp. This special lamp is provided by the Canadian company Trojan-UV. It is intended for water treatment because it has a broad emission band in the UV and visible spectral range. The geometrical and electrical provided with this lamp are shown in Table 4 below:

Characteristics	values
Inter-electrode length (cm)	25
Diameter (mm)	22
Nominal Arc current (Arms)	6,8
Maximum arc current (Arms)	7,9
Nominal arc voltage (Vrms)	440±5%
Maximum arc voltage (Vrms)	550
Power (W)	3000

Table 4. Electrical and geometrical characteristics of the medium pressure lamp

4.3.1 Electrical measurements

In this part we will present some electrical measurements carried out under pulsed current. To power the lamp at rated power of 3 kW, were overlaid seven pulse of amplitude equal to 4 A on a rectangular current level of 5.5 A in each half cycle of the rectangular current. The pulse duration is about 0.5 ms and the base frequency of the rectangular current is 50 Hz. In figure 10 we represent, the current and the instantaneous power consumed by the lamp in pulsed mode (Bouslimi et al., 2008).

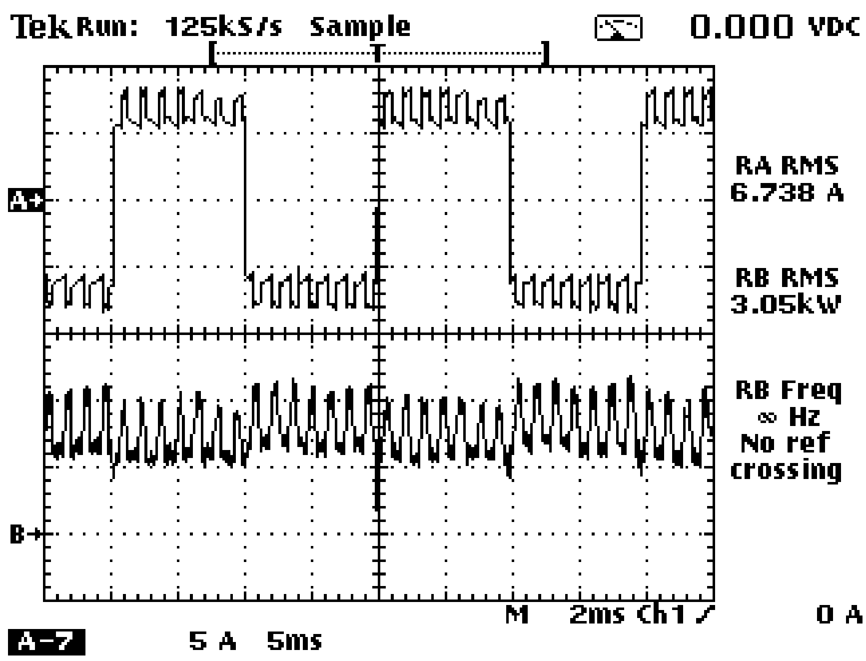

Fig. 10. Instantaneous Current and power in the lamp in pulsed mode, A: Current (5 A/div), B: Power (2 kW/div), Time: 5 ms/div

Note that the instantaneous peak of power in the medium pressure lamp reaches almost twice the level. Thus, it is because the impulses that are causing successive short duration peaks of high power. The radiation produced, called pulsed light, is required by some photochemical applications such as disinfection of wastewater or drinking.

4.3.2 Spectral flux measurements in ultraviolet and visible band

For this lamp, in order to evaluate the influence of pulses on the spectral flux of ultraviolet and visible radiation, spectral measurements are performed with a rectangular and pulsed current. The results obtained for the same power consumed by the lamp are shown in figures (11, 12, 13 and 14).

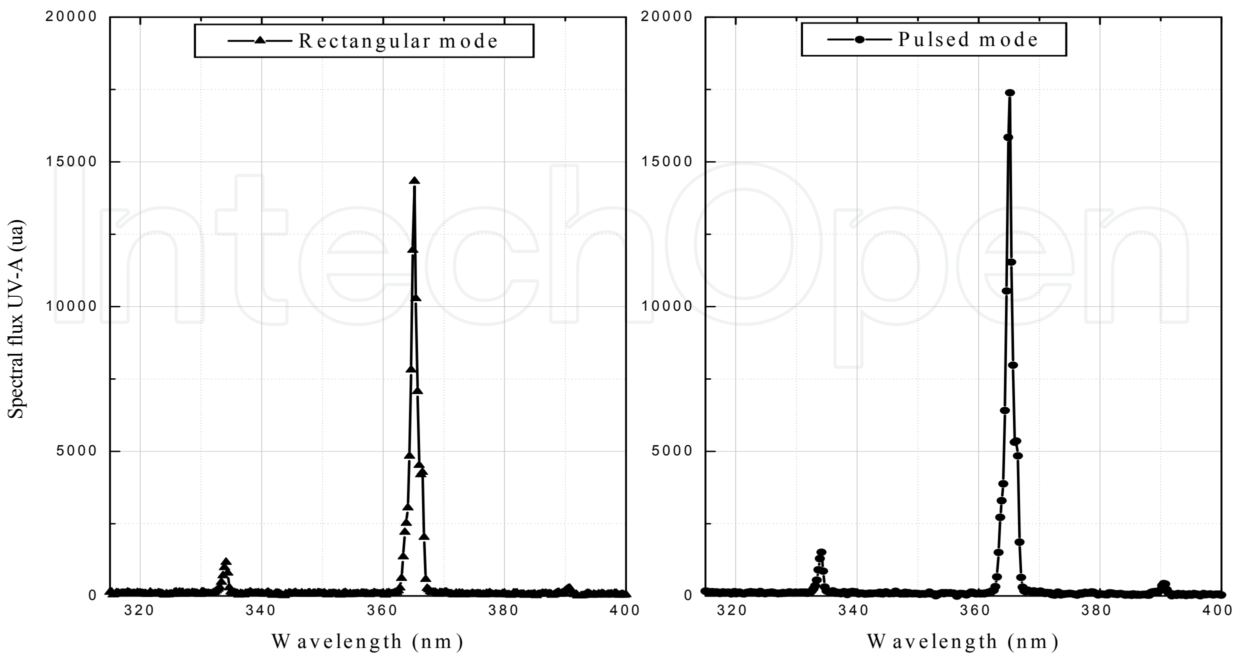

Fig. 11. Spectral flux band UV-A with two feeding modes of current: rectangular and pulsed

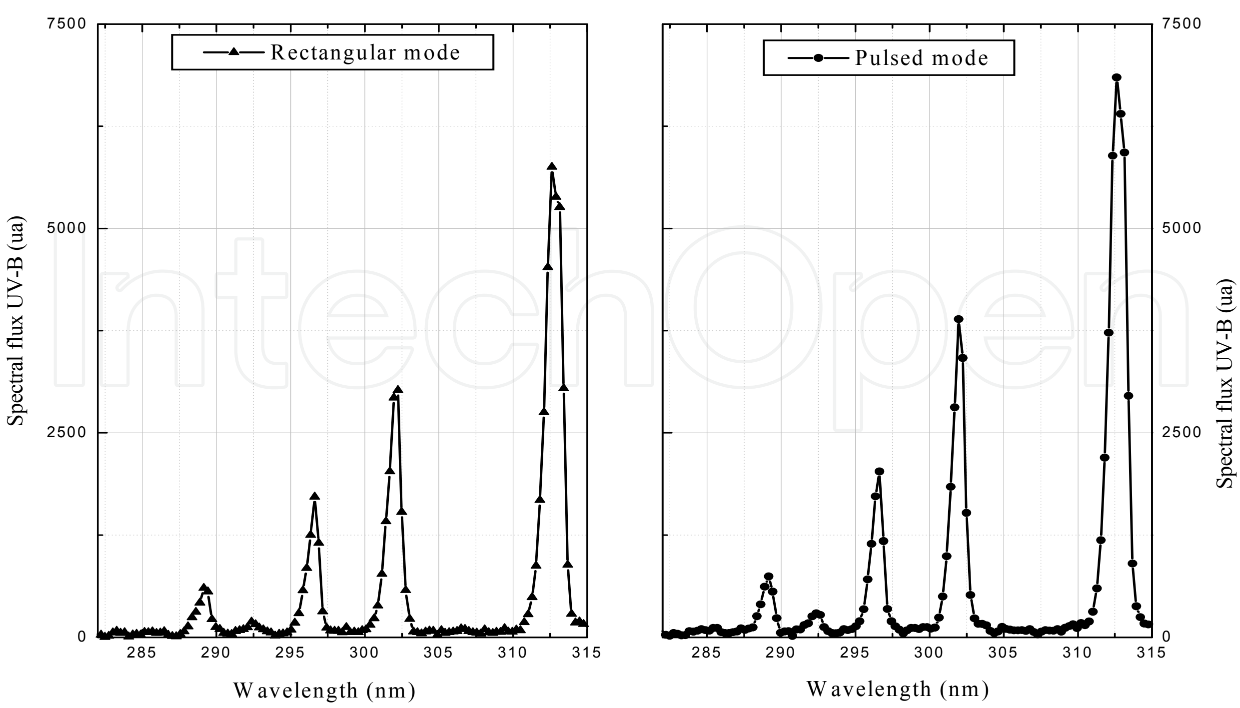

Fig. 12. Spectral flux band UV-B with two feeding modes of current: rectangular and pulsed

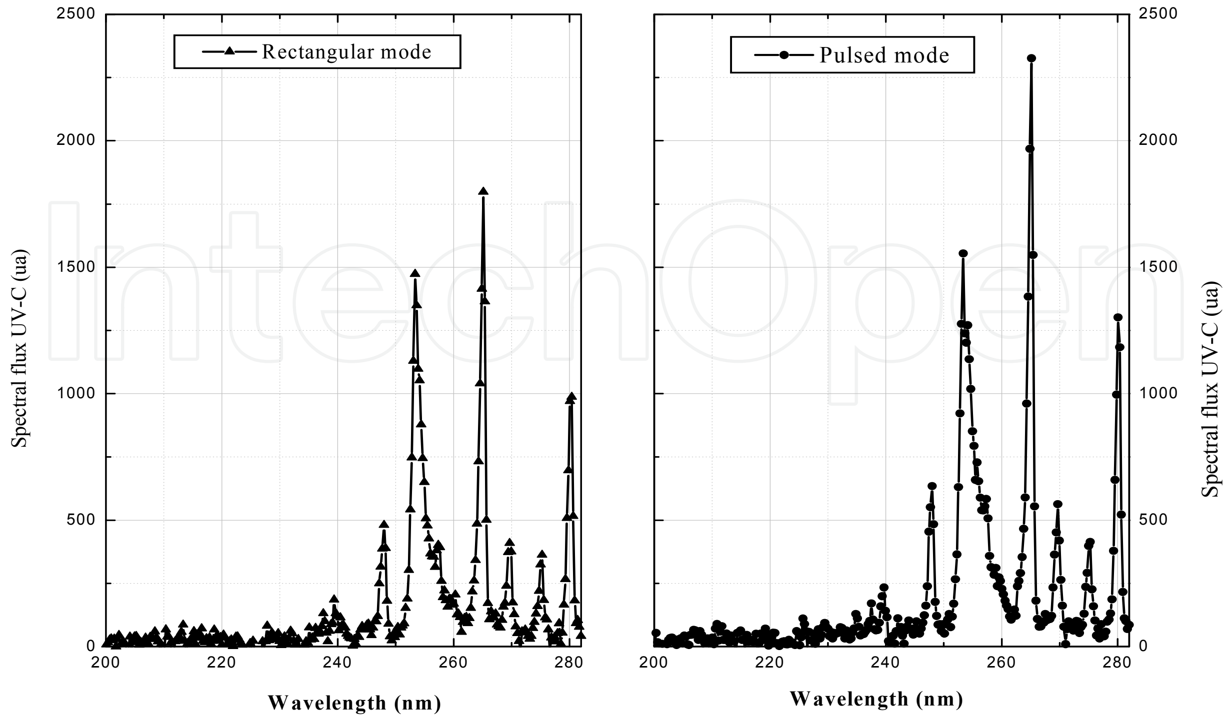

Fig. 13. Spectral flux of UV-C band with two feeding modes of current: rectangular and pulsed

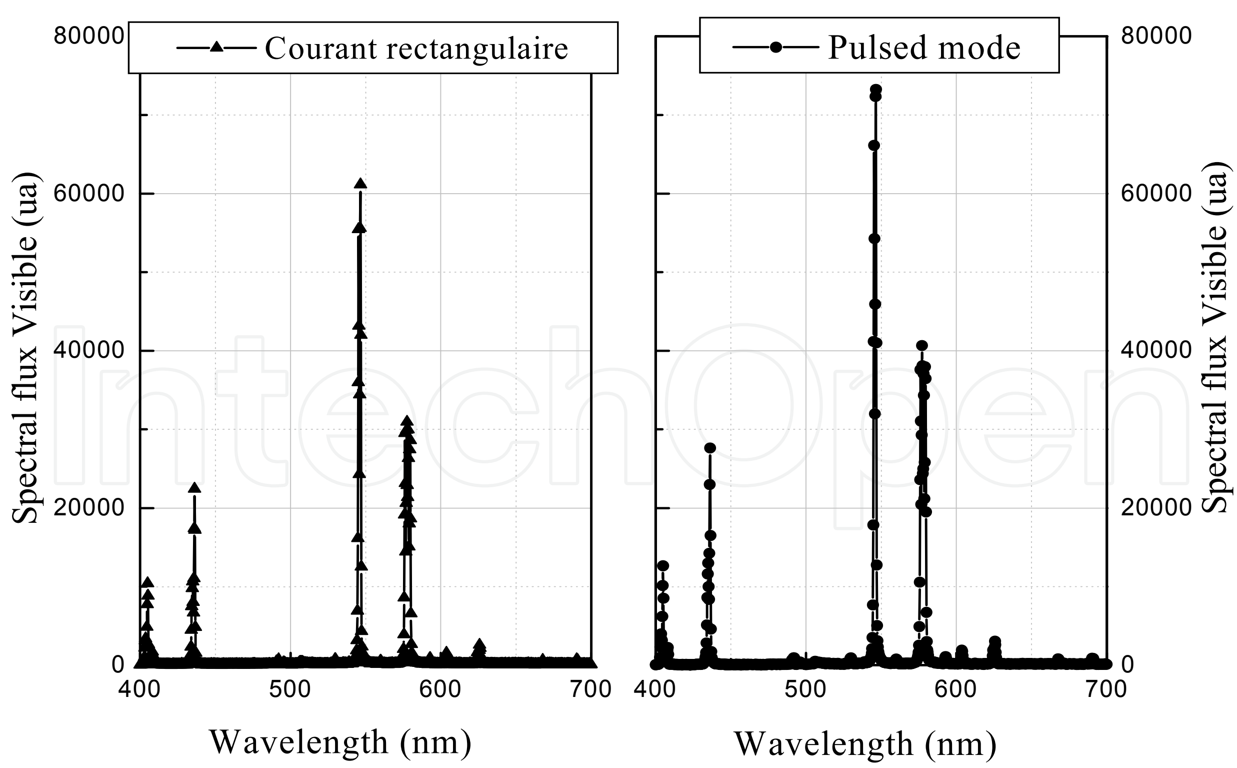

Fig. 14. Spectral flux of visible band with two feeding modes of current: rectangular and pulsed.

Spectral bands (nm)		UVC 200-280	UVB 280-315	UVA 315-400	UV total 200-400	Visible 400-700
Relative tota flux (u.a)	Rectangular	11330	16495	29415	57108	308235
	Pulsed	14760	20195	35945	70826	380810
Relative increase (%)		30,2	22,4	22,1	24,2	23,5

Table 5. Comparison between the relative total flux of UV and visible radiation bands for two feeding modes of current: rectangular and pulsed (medium pressure lamp)

4.3.3 Discussion of results

In figures (11, 12, 13 and 14) there is a clear increase in the flux of all the spectral lines measured in pulsed mode for the same power in rectangular mode. However, the increase is particularly important for the band UVC spectrum, dominated by the 254 nm line and in particular the molecular line 265 nm, very used to destroy bacteria. Increases in the UVA, UVB and visible, important, too, are substantially identical (about 23%). The increase of the radiation is mainly due to the increase of the electron temperature in the medium pressure discharge lamp. Note that for this lamp the increase is important both in the UV than in the visible.

5. Conclusion

In this work, we have exposed the UV radiation and its applications in photochemistry. The mechanism of UV disinfection and the biological effects are also presented. Some discharge lamps and their power suppliers are showed.

In a great part of this work, we have showing some experimental results carried out on two types of mercury lamp, considered as UV sources: high and medium pressure.

An attempt to raise the efficacy and to improve the performance was made by going to pulse operation instead of operating the arc on a rectangular wave power supply. It is possible with this method to increase the efficacy to sufficiently high values.

The spectral flux results obtained highlight and evaluate the effectiveness of the pulsed current on the radiation production in the ultraviolet and the visible part of the spectrum.

We also note that the improvement of the production of radiation considered, interested many photochemical applications and field lighting.

The applications of the pulsed supply with short duration and sharp dismounted front are considered as relatively recent techniques. It allows us to study in the future, the dynamic behavior of the discharge lamps and their instantaneous effects on the microorganisms in various water treatments (drinking water, waste water, seawater for aquaculture and shellfish culture).

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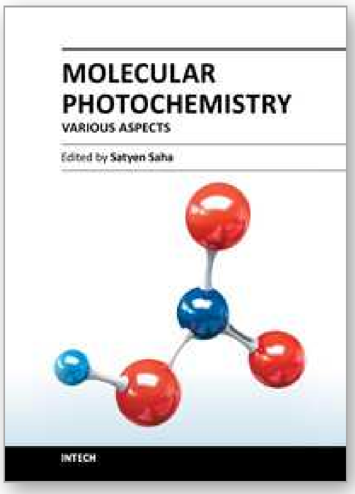

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There have been various comprehensive and stand-alone text books on the introduction to Molecular Photochemistry which provide crystal clear concepts on fundamental issues. This book entitled "Molecular Photochemistry - Various Aspects" presents various advanced topics that inherently utilizes those core concepts/techniques to various advanced fields of photochemistry and are generally not available. The purpose of publication of this book is actually an effort to bring many such important topics clubbed together. The goal of this book is to familiarize both research scholars and post graduate students with recent advancement in various fields related to Photochemistry. The book is broadly divided in five parts: the photochemistry I) in solution, II) of metal oxides, III) in biology, IV) the computational aspects and V) applications. Each part provides unique aspect of photochemistry. These exciting chapters clearly indicate that the future of photochemistry like in any other burgeoning field is more exciting than the past.