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# A comparison for application time of electrical discharge onto 3-acetamidocoumarin molecule

Erol Taşal [a], Murat Tanışlı [b,*]

[a] Eskişehir Osmangazi University, Faculty of Arts and Sciences, Department of Physics, Eskişehir, Turkey
[b] Anadolu University, Science Faculty, Department of Physics, 26470 Eskişehir, Turkey

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ABSTRACT

A topic of great interest is discussed as the atmospheric-pressure non-equilibrium plasma jets and their applications. In this study, our plasma generated here can be described as the dielectric barrier discharge-like. It is known that these types of plasma can be used in various applications like surface modification, inactivation of microorganism etc. An interesting application of the atmospheric pressure plasma is decomposing of the long chemical chain molecules. We present a new decomposing method for the molecules. Investigation of molecular structure of coumarin is very important. We perform the structural analysis of molecules that interact with atmospheric pressure plasma jet. The 3-acetamidocoumarin molecule plays an important role in biology and medicine. It has physiological effects and it has been used to product of drug for many diseases such as treatment of burns, brucellosis-rheumatic diseases and cancer. The atmospheric-pressure non-equilibrium plasma jet of argon (Ar) has been formed by ac-power generator with frequency – 24 kHz and voltage-12 kV. FT-IR spectra of the molecule "3-acetamidocoumarin" (abbreviated as 3ADC) dissolved in ethanol and methanol have been analysed after applying (application times, 1 minute and 3 minutes) the plasma, for the first time. Also the changes of structure have been evaluated. 4C-O band is broken and the main photoreactions were observed the characteristic IR intense band due to the antisymmetric stretching vibration of the ketene (-3C═4C═O) group. New photoproduct is obtained in the E arrangement of the (O═) 5C-10C═11C-3C (═4C═O) fragment.


## 1. Introduction

It is thought that the atmospheric pressure plasma may be more popular research area about material and surface treatment. Atmospheric pressure plasma can change the surface free energy in some applications. This is the great industrial application. Plasma jets can be created pulsed current. Especially high frequency and radio frequency (RF) power supply is the most desire option. Atmospheric pressure plasmas are also used to sterilization process, $H_2$ gas and diamond carbon production, $CH_4$ or $CO_2$ molecules degradations, ozone productions. The instability caused by filamentation in dielectric barrier discharge plasma may be possible at the atmospheric pressure. The two important facts for generating the atmospheric pressure non-equilibrium plasma jets are the low applied electric field and the high electron-heavy particle collision frequency. Plasma jets operating with noble gases such as argon, neon… can be classified into four ways, i.e. dielectric-free electrode jets, dielectric barrier discharge jets, dielectric barrier discharge-like jets and single electrode jets. Dielectric barrier discharges (DBD) actuating with either sinusoidal signals or pulsed high voltages are the most common atmospheric pressure system currently in use and the dielectric prevents the formation of high temperature arcs. Higher frequencies are also used at atmospheric pressure [1–11]. The atmospheric pressure plasmas have some significant advantages. Namely, the large and expensive vacuum system is not required. Therefore they can provide a cheaper and more convenient alternative in comparison with low-pressure plasmas. Various configurations and applications of the atmospheric pressure dielectric barrier discharges have been generally examined nowadays. The atmospheric pressure dielectric barrier discharges are very important in many fields of industry, such as large scale of ozone generation, surface polymerization, exhaust gas treatment plasma using spray droplets, sterilization of surfaces and cavities, inactivation of microorganisms, medicines, pollution control, deposition of thin film… There are several studies in literature that investigated the atmospheric pressure dielectric barrier discharge (DBD) and its applications. A device was developed to generate a non-equilibrium atmospheric-pressure plasma treatment (APPT) at low temperature and supplied by a high-voltage pulsed power source. Atmospheric pressure radio-frequency (RF) plasmas were successfully applied to a large set of metals such as titanium, copper and gold, and to non-metals such as silicon and III–V compounds. Due to the reaction chemistry at a low gas temperature without the requirement of a vacuum system, the low-

* Corresponding author.
*E-mail addresses:* etasal@ogu.edu.tr (E. Taşal), mtanisli@anadolu.edu.tr (M. Tanışlı).

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temperature atmospheric-pressure plasmas are also taken into account in industrial and biomedical applications. It can be used to degradation of the chemical bond and re-order of the chemical bonds in molecules chains. Thin film deposition and plasma etching were operated at atmospheric pressure with radio frequency (RF) jet plasmas. However, due to non-homogeneity, thin film deposition is not easily made with DBD in general. Non-thermal atmospheric-pressure plasma jets are characterized by providing their operational parameters such as their electrodes system, plasma temperature, geometrical sizes of jet (radius and length) power, and gas or gas mixtures used [10–24].

Due to use as dyes owing to their efficient light emission properties, high stability and easy synthesis, the coumarins and its derivatives have an important role. Coumarins are important natural occurring and synthetic compounds which present several relevant applications. Principally, they exhibit different biological activities, including, anti-HIV, anti-tumour, anti-hypertension, anti-arrhythmia and anti-osteoporosis activities, weak toxicity, anticoagulant, spasmolytic, diuretic, anthelmintic and hypoglycaemic actions. Coumarins and coumarin derivatives are of considerable medical and biological interest, representing important physiological effects. Natural products like esculetin, fraxetin, daphnetin and other related coumarin derivatives are also recognised to possess anti-inflammatory as well as anti-oxidant activities. Coumarins and coumarin derivatives are also currently used in perfumes and agrochemicals production [25–31].

## 2. Experimental

### 2.1. System

M + W Instruments Mass-Stream D6300 series flowmeter controls the gas flow rate. ELES HV-711GK5 is specially designed for the main power supply with adjustable frequency and voltage of the system. The power supply provides 10 kHz–25 kHz and 4 kV–20 kV input frequency and voltage adjustments, respectively. Ocean Optics HR2000+ yields the emission spectra of argon (Ar) atmospheric plasma jet. Fluke CNXt3000 thermocouple has been also chosen to measure the initial temperature of the plasma (end of tube).

FT-IR spectra were recorded on a Jasco FT/IR-300 E spectrophotometer using the KBr pellet technique in the range 4000–400 $cm^{-1}$.

Our system has the main body made by quartz, an electrode on it and a tungsten rod. A fixing stand is also designed. Schematic diagram of the system is represented in Fig. 1. Here the plasma temperature is measured from the jet region. Argon (Ar) gas is sent from the head of the quartz tube to the system. 24 kHz frequency and 12 kV input voltage with AC power supply have been selected and the flow rate is fixed to 2.0 lt/min. Application distance has also been preferred as 2 cm.

The emission spectra of the discharge are collected after the plasma obtained. The spectrum can be shown in Fig. 2. The temperature for the first moment of the plasma generation has also been observed as 41.5 ° C.

### 2.2. 3-Acetamidocoumarin molecule

The structure of 3-acetamidocoumarin molecule (3-ADC) purchased from Aldrich Company with a stated purity of 99% is demonstrated in Fig. 3.

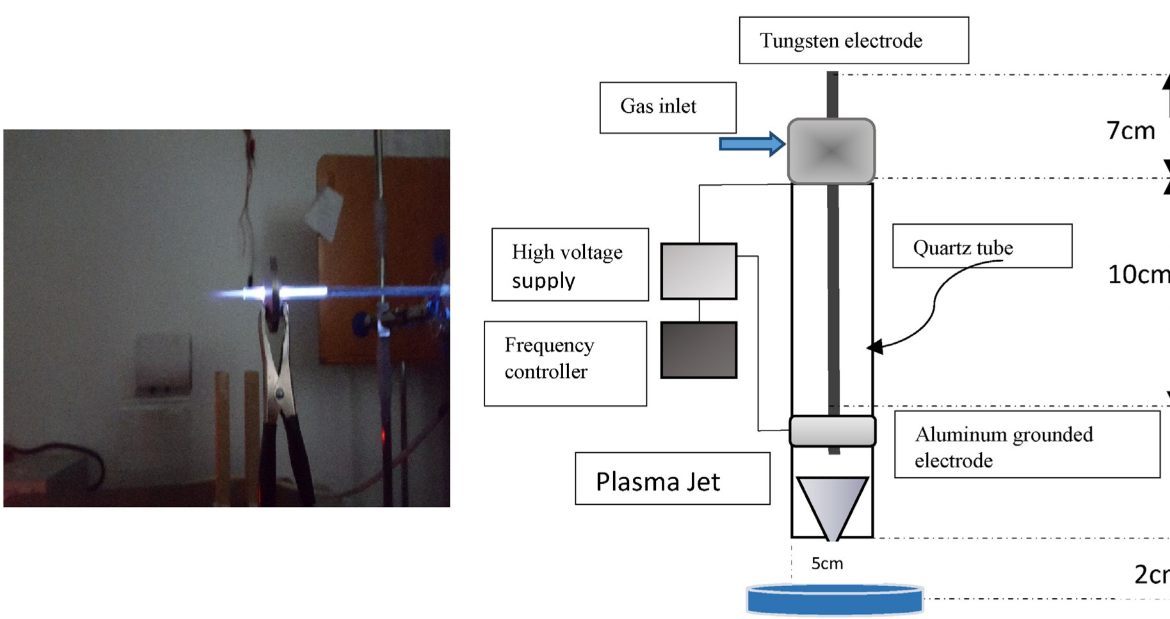
## 3. Vibrational spectra (FT-IR spectra)

Atmospheric plasma jet of Ar at room temperature has been applied separately for 1 minute and 3 minutes to the liquids prepared with solutions. Also the changes of molecule structure in liquid phase using different solvents as ethanol and methanol have been evaluated. Each solution was prepared as about $5 \times 10^{-4}$ M.

FT-IR spectra of 3-ADC molecule dissolved in ethanol and methanol solvents before and after APPT (duration: 1 min) are represented in Figs. (4 and 5).

### 3.1. N–H vibrations modes

N-H vibrations modes for 3-ADC molecule in liquid phase prepared with ethanol before and after APPT were observed at 3329.47 $cm^{-1}$ and 3329.94 $cm^{-1}$ in Fig. 4, respectively.N –H vibrations modes of 3-ADC molecule with methanol before and after APPT were observed 3412.78 $cm^{-1}$ and 3412.97 $cm^{-1}$ wavenumbers in Fig. 5. There is a little shifting for this mode. There are quite little changes.The wavenumbers for N-H vibrations modes are observed at 666.00 $cm^{-1}$, 666.82 $cm^{-1}$




(a) (b)

**Fig. 1.** (a) Atmospheric pressure plasma jet's image and (b) schematic diagram of system.