Identification of UV laser removed blockages in vascular tissue.

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Abstract

Aorta was irradiated with pulsed exaimer laser at fluence well over the ablation threshold a visible plum emanating from the front surface studies of the plume and identification of lumnous products involved, were carried out using spectroscopy in the visible-UV spectroscopy. Analyzing the spectra shows no significant differences between major features of normal and atheroma tissue, with one exception of Ca emission which appeared strong in the diseased tissue.

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1. Introduction

Since 1982 (1, 9) laser material interaction received a considerable impetus from the discovery that short wavelength Examer laser could produce extremely precise removed of polymaric materials. Following several related papers showing the generaly of this result for organic polymers (3, 10), studies was extended to produce extremely precise incisions in biological materials with little or no apparent thermal distribution. The uses of excimer lasers in angioplasty have received considerable attention since these first reports by Terikel et al (4) and lansker et al (5). The interaction of excimer laser is of potential surgical importance primarily as a tool for laser angioplasty that is the removal of blokagas in blood vessels by ablation or veporization with fiber delivered radiation.

The arteries as involved with carrying the blood from the heart to the tissue and consist of the structure inner most coat or layer intima, middle coat or tunica media and outer coat. In general the chemical composition of human heart and arteries is complex as they are made up of many organism and tissues. The composition is determined by chemical analysis. The chemical composition of arteries in adults is ~ 80 % water and ~ 20 % solid tissue material.

The solid tissue composed of Na K,CL,Mg,Ca,P,Ch,Cr,C,O,H .. .. etc.

In this paper the 248 nm excimer laser spectroscopy of the ablation plume at high fluence were carried out in vacuum and gases environment.

2. Experimental Setup

Studies of the plume and an identification of the luminous produts involved were carried out using spectroscopy in the visible UV. Spectral region. Fig. (1) Shows the experimental apparatu used.

The target was mounted in a cell which could be evacuated using a rotary pump allowing the effect of the background gas and pressure to be investigated. The cell was equipped with three windows allowing visual observation, spectroscopic recording and laser access. The entire cell was mounted on independent X- Y - Z translators which enabled the target to be moved horizontally, and vertically, allowing the laser spot position on the tissue sample to be varied.

A 60 mJ, 8ns pulse durstion, KrF laser (lumbda physic EMG 50 E) operating at arepetition rate of 50 Hz was used to ablate the tissue. The laser output was focused onto the target using a 25 cm focal length lens. A grating monocromator Bantham Instrument model M300 (Benthan Instrument Ltd, Reading U.K.) with a photomultiplier detector was used to record the spectrum. To obtain time - integrated spectra the output was taken to a chart recorder (CR 600 Recorder, J. J. lioyd instrument ltd, U. K.) Via an integrating amplifier with a gain of unity and integration time of one second. The plume produced by ablation was imaged on to the monochromator slit using a 15 cm focal length quartz lens. The monochromator was initially calibrated using standered wavelength from the helium-neon laser, and the KRF laser and using a polynomial fit to describe the (slightly) non-linear wavelength monochromator counter relationship.

3. Result and Conclusion

In low pressure air (05 tor) the apperance of the plume was very similar for both normal and atheroma tissue samples irradiated with KRF laser . The plume structure resembled a (Jet) of products leaving the surface which developed into a ball shape some 5-10 mm from the surface. The plume was yellowish in coloured near the surface but became purple at longer distance. This behaviour is consistent with other (6,8) observation which indicate that the fragments leave the target surface at high spead and after a short distance mix with low pressure air and combust with it.

When the fluencies were increased above 800 mJ the central region of the plume (i.e region directly in front of the irradiated spot close to the target) became a much brightor yellowish color. When the gas pressure was changed to 10 torr of argon the plume was of roughly the same shape but became much brighter. These were the only conditions under which spectra of the plume were recorded. Spectral features were identified using standard tables listed in (7, 8).

Figure (2) shows the spectrum recorded for normal aorta in 0.5 torr of air and in which can be seen eight main features three of which form part of the CN violent system (ß Σ → A transition) with bands at 358.3 , 385.0 and 388 nm. Of the others, one belongs to the Ca line at 422.6 nm, two belong to the C2 band system (A → X transition) with heads at 468 nm. and 516 nm , one to the Na line at 590.89 nm and one to H line at 656.2 nm .

For the atheroma tissue under the same irradiation and gas conditions the spectrum obtained differs from that for normal tissue with more features being pressent although these are not very clear fig.(3) .

When 10 torr of argon replaced the air in the cell the spectrum of normal tissue figure (4) using 248 KrF laser tended to be stronger in intensity but spectrally very similar to that obtained in air under identifical conditions For the atheroma under the same conditions, fig.(5) the structure is much stronger and the spectrum again shows more bands then abserved for normal tissue. The band at 431 nm. is most likely due to CH emmission . Another feature of the atheroma spectra is the appearance of new Ca lines at 393.3 and 512.47 nm.

The results indicate that whilst small detailed changes in the spectra appear there is no strongly significant difference between the major features for atheroma and normal tissue. The features that apper are similar to those that dominate in organic polymer plumes with exception of sodium and calcium.

The former is attrebuteble to the saline content of the sample, the latter is however probably an intrinsic component of the tissue and present in longer quantities for diseased tissue.

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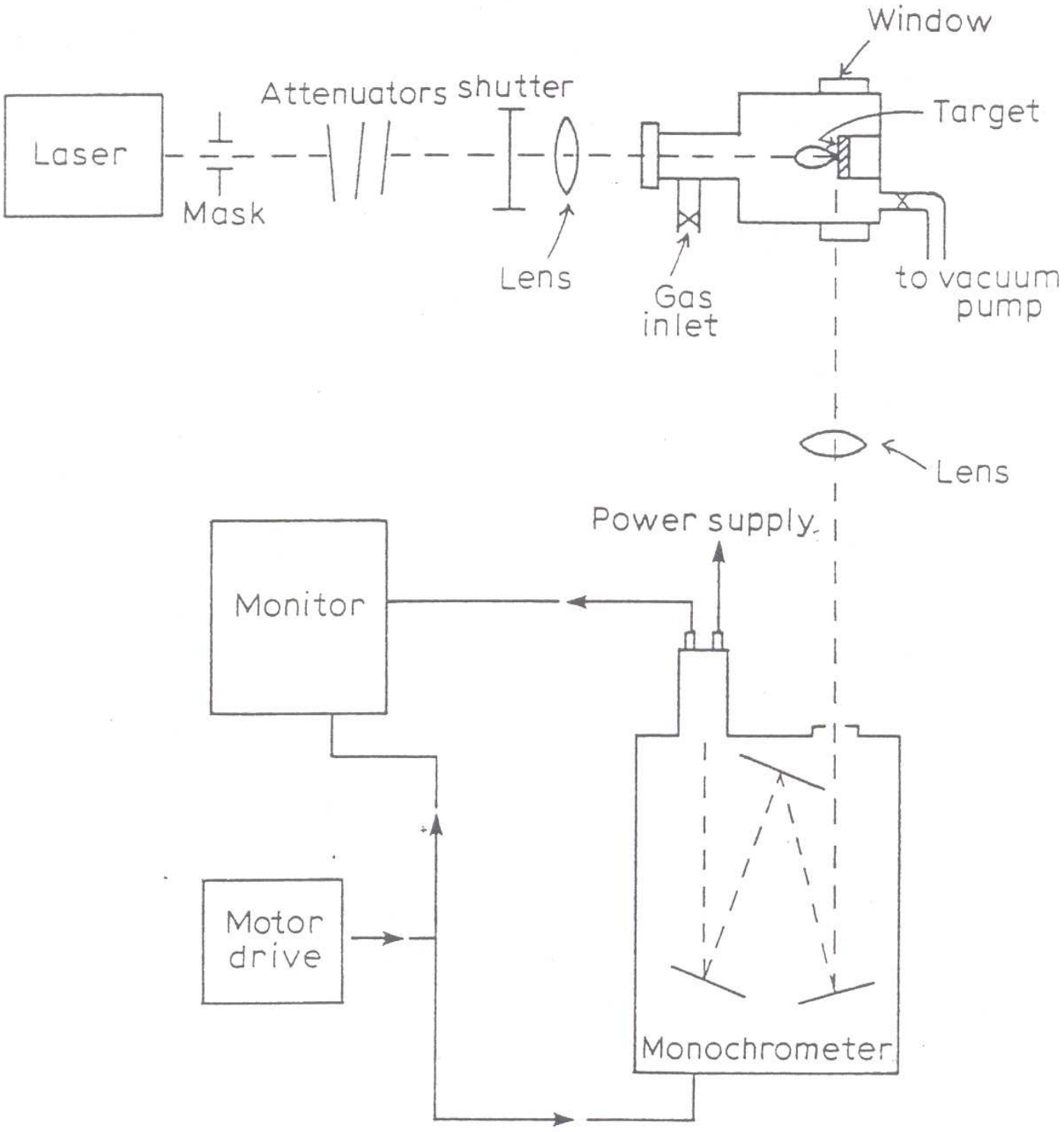

Figure 1 Experimental apparatus to study the plume.

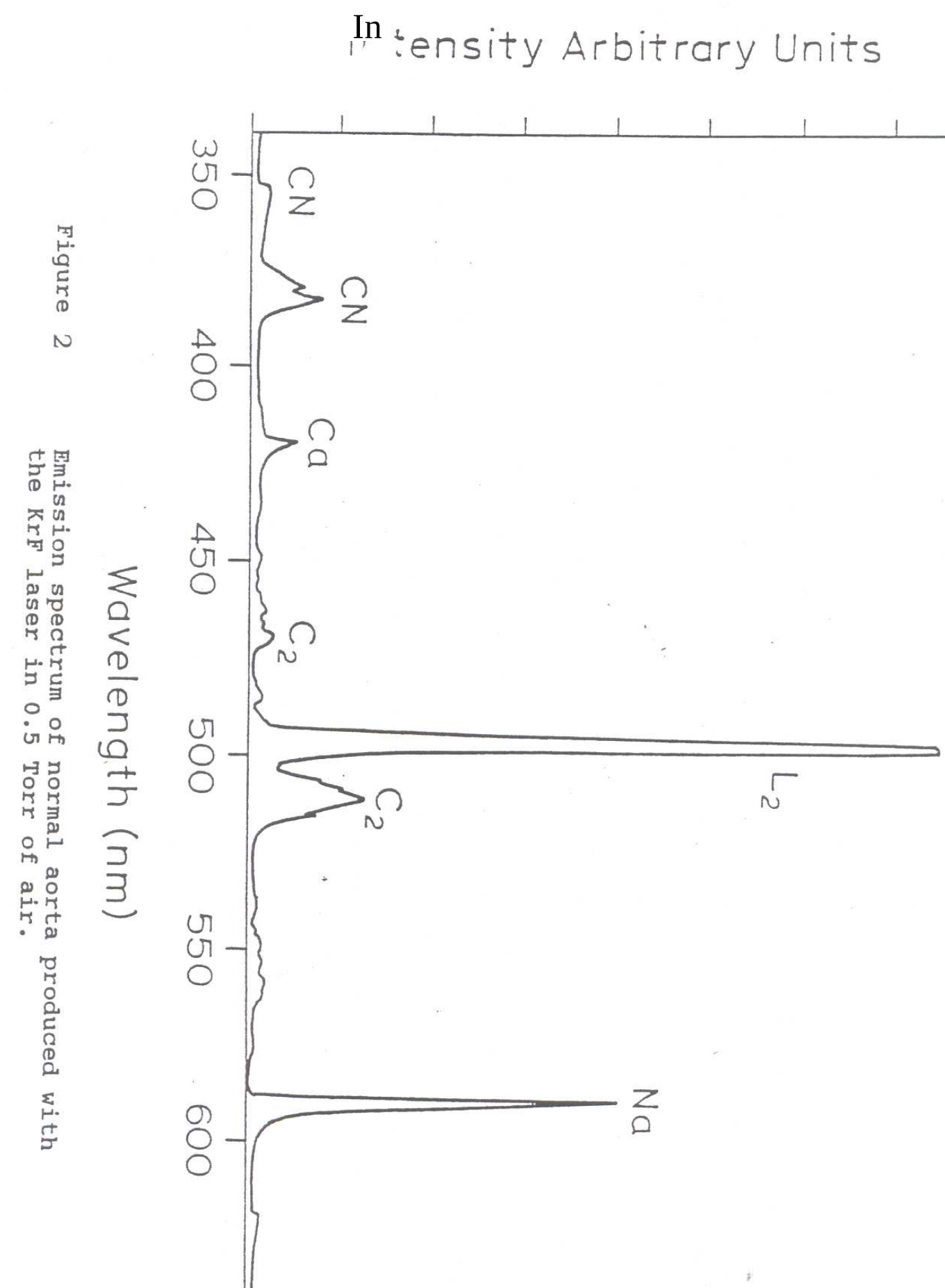

Figure 2 Emission spectrum of normal aorta produced with the KrF laser in 0.5 Torr of air.

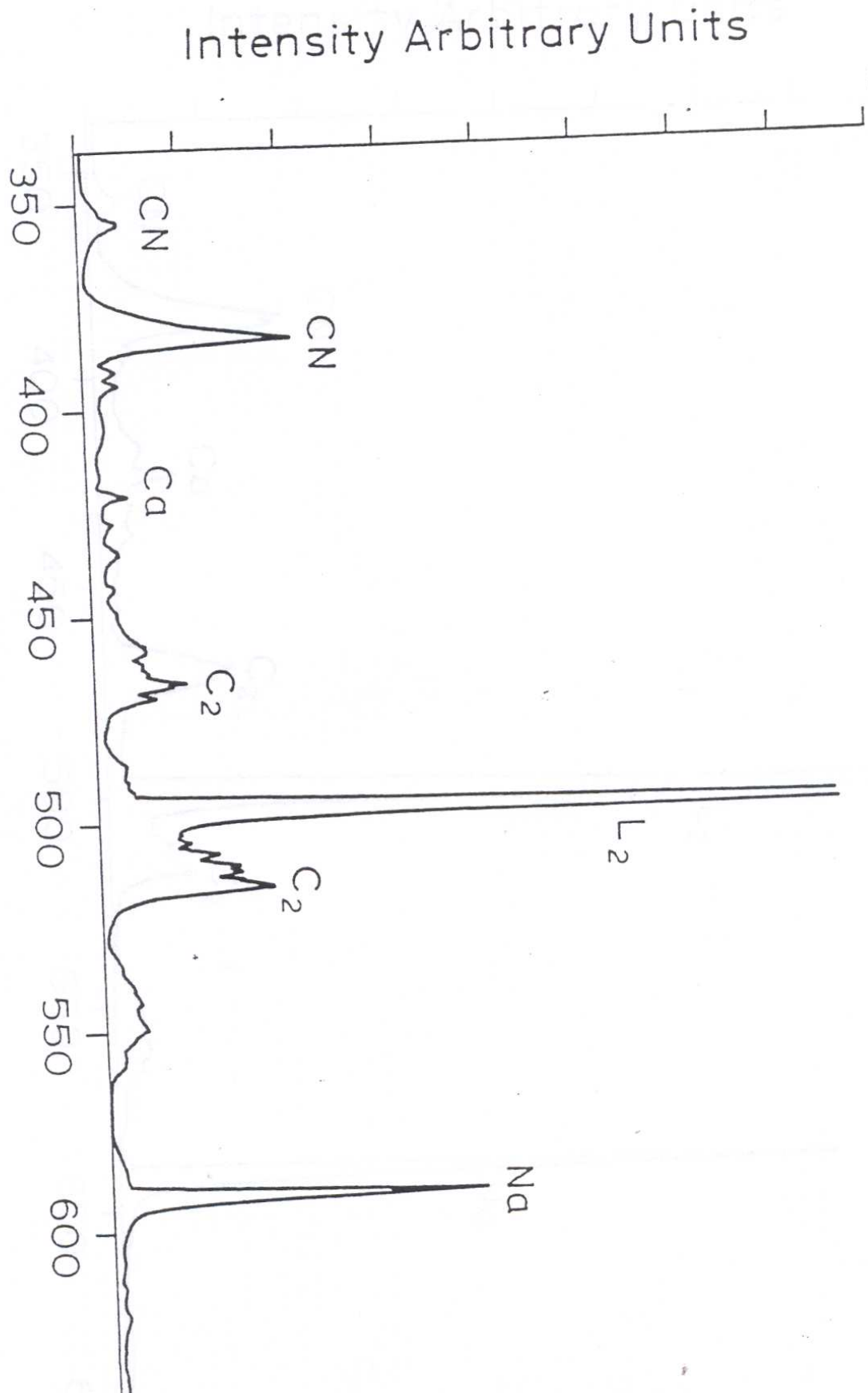

Figure 3 Emission spectrum of atheroma tissue produced with the KrF laser in 0.5 Torr of air.

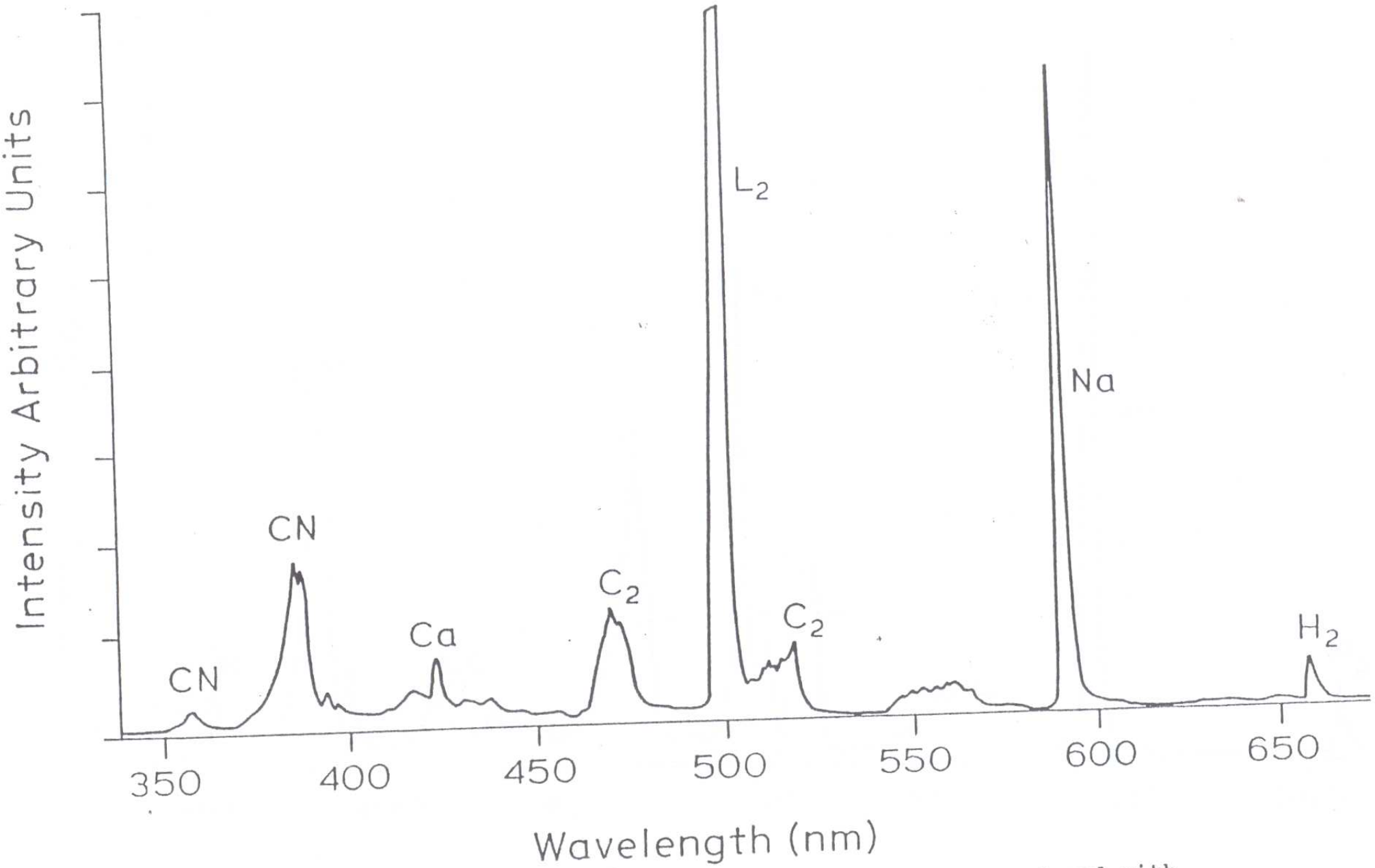

Figure 4 Emission spectrum of normal aorta produced with the KrF laser in 10 Torr of argon.

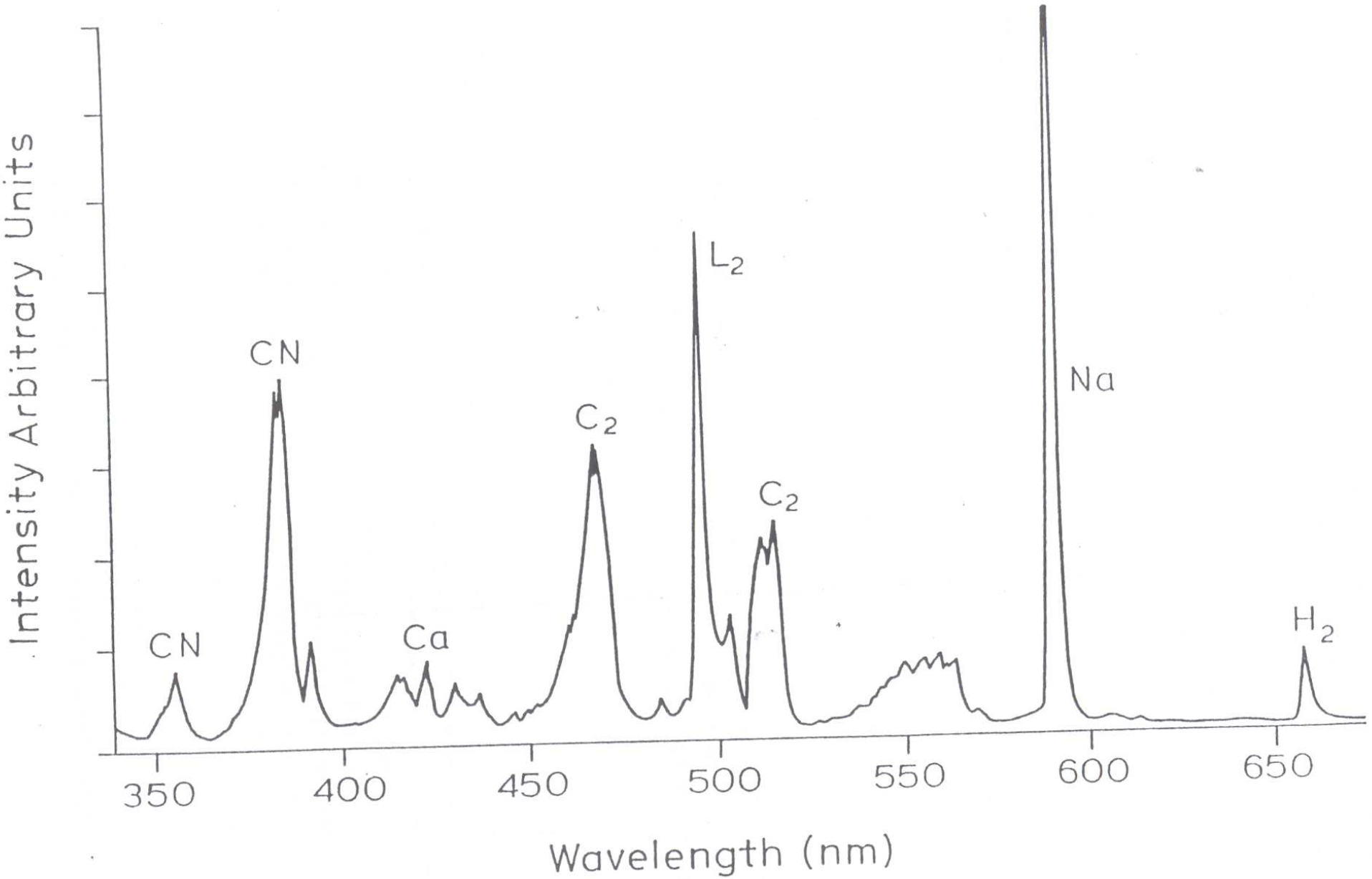

Figure 5 Emission spectrum of atheroma tissue produced with the KrF laser in 10 Torr of argon.