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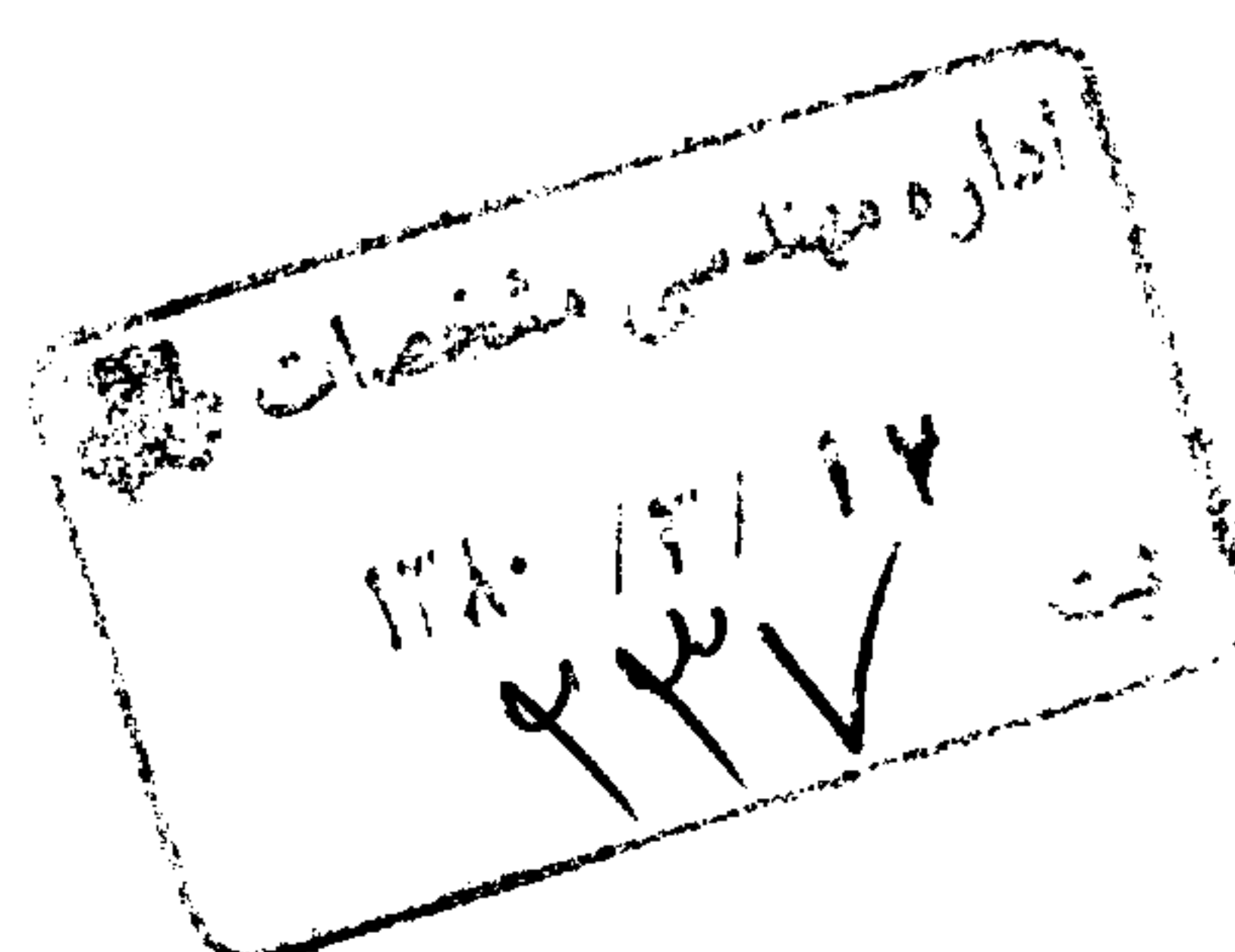
General Rules for Chemical
Analysis of Atomic Absorption
Spectrochemical

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1. Scope of application

This standard shall specify usage of analytical equipment for atomic absorption of light for the use of analysis in our company.

However, quantity of 13 elements of Cu, Mg, Ti, Sn, Pb, Ca, Zn, Fe, Mn, Ni, V, W must be fixed using analytical equipment for atomic absorption of light in order to analyze elements of all metals.

2. Meaning of vocabularies

Meanings of vocabularies used for analysis of atomic absorption of light are as follows.

(1) Flash back

The spread of fire inside burner when the speed of burning is fast and gushing speed of mixed gas is slow.

(2) Resonance line : Analysis of atomic absorption of light

Radiated spectrum line when an atom transfers to ground state after the atom absorbs light from outside.

(3) Neighboring line

Another spectrum line having a similar wavelength with acquired spectrum line.

(4) Atomic absorptivity or atomic extinction coefficient : analysis of atomic absorption of light

$$E_{AA} = \frac{\text{Log}_{10} I_{0\nu} / I_{\nu}}{C \cdot \ell}$$

Here, $I_{0\nu}$ is intensity of the moment that the light of frequency ν transmit the fume not

having the object atom, I_{ν} is intensity of the moment that the light of frequency ν transmit the fume having the object atom,

C is concentration of object atom in the fume and ℓ is length of optical way in the fume.

- (5) Atomic absorption spectrum : When the light passes through atomic vapor layer of atomic absorption analytical material, it absorbs the light of each specific wavelength. The spectrum derived from dispersion of the speed of the light.
- (6) Atomic absorption (Spectro)photometer: Photometer used for measurement of atomic absorption (Spectro)
- (7) Atomic absorption (Spectro) photometry : Measurement of relation with concentration of specific elements and degree of absorption of light (Usually not revised value) of a bright line among the samples using atomic absorption spectrum.
- (8) Atomic absorption (Spectro-chemical)analysis : Chemical analysis of measurement of atomic absorption of light.
- (9) Filter gas : Atomic absorption analysis
Gas inserted at hollow cathod lamp
- (10) Fuel-lean flame : Flame, atomic absorption analysis
Flames that the values of inflammable gas/ assisting gas for burning are small.
- (11) Slot burner
Burner that outlet of gas is slender and long.
- (12) Line width
Width of spectrum line
- (13) Line profile : Atomic absorption analysis
Curve, which indicate intensity distribution of spectrum line about packing.
- (14) Total consumption burner, atomizer burner : Flame, atomic absorption analysis
Burner that the method is atomic vaporization by atomizing all quantity in flame directly after transforming absorbed sample solution into minute particles.
- (15) Multi-cathod hollow cathod lamp: Hollow cathod lamp having more than 2 hollow cathods.
- (16) Multi-element hollow cathod lamp : Hollow cathod lamp having more than a hollow cathod and more than 2 object elements.

(17) Full-rich flame : Flame, atomic absorption analysis

Flames that the values of inflammable gas/ assisting gas for burning are large.

(18) Hollow cathod lamp : A discharge tube that 1 or several of hollow cathods, which have object elements, are inserted with low pressure neon.**(19) Atomizer : Flame, atomic absorption analysis**

Exhaust equipment in order to change sample into minute particles.

(20) Atomizer chamber : Flame, atomic absorption analysis

Equipment making minute particles that are made by atomizer and finer and are separated from large particles.

(21) Multi-path

Device that have the light transmit several times in flame using reflection in order to make absorption large by elongate optical length.

(22) Pre-mix type burner : Flame, atomic absorption analysis

Burner that inserts inflammable gas, assisting gas for burning and sample into flame by mixing in atomizer chamber.

3. Principles

Atomic absorption analysis is the method that use phenomenon that ground state atom of any element selects and absorbs light of specific wavelength (Resonant line) emitting from the same element and quantity of element concentration among samples is fixed by measuring degree of absorbed light about hollow cathod wavelength including dual atomic vapor layer as object elements after vaporizing atoms by dissociating samples using suitable method.

(1) Atomic absorption of light

Atomic absorption analysis is the method that fix quantity of element concentration among samples by measuring degree of absorbed light about each specific wavelength by measuring light of photoelectricity using phenomenon that created ground state atom

absorb light of specific wavelength penetrating dual atomic vapor layer after vaporizing atoms by dissociating samples using suitable method.

(2) Luminescence of flame

Luminescence of flame analysis is the method that fix the quantity of element concentration in the sample by measurement of intensity of light through radiating light of specific wavelength of the element when the excited electron comes to the ground state after making ground state electron of object element into excited state by thermal energy made by burning samples with flame.

(3) Principles

The relation between degree of light absorption by atom and atomic vapor density is as follows.

Emission from a light source of frequency ν and intensity $I_{0\nu}$ transmit atomic vapor layer of length ℓ and is absorbed by atom and then the intensity becomes I_ν

$$I_\nu = I_{0\nu} e^{-k_\nu \ell} \dots\dots\dots (1)$$

However, this value is called absorption coefficient at frequency ν as a proportional constant according to k_ν and has different value according to ν . In addition, the value of integral absorption coefficient $\int k_\nu d\nu$ about k_ν is indicated at following formula.

$$\int k_\nu d\nu = \frac{\pi e^2}{m c} N_\nu f \dots\dots\dots (2)$$

e : Electric quantity of electron

m : Mass of electron

C : Speed of light

N_ν : Atomic number per 1 cm^3 related to absorption in the limit of $\nu \sim \nu + d\nu$, i.e atomic density

f : Intensity of frequency difference

Formula (2) shows that integral absorption coefficient is proportional to atomic number of ground state N_v (Atomic density).

When N_v states atomic density in flame used for atomizing sample, formula (2) becomes

$$\int k_\nu d\nu = \frac{\pi e^2}{m c} N f \dots\dots\dots (3)$$

and this is proportional to integral absorption coefficient and atomic density N in flame.

In atomic absorption analysis, it is normal to obtain N by measuring $K_{\max}$ as absorption in the center of atomic absorption spectrum line instead of obtaining integral absorption coefficient using a bright line spectrum that width of line is narrow instead of atomic absorption spectrum as a light source.

In case that analysis condition of concentration C of object elements and atomic vapor density N is fixed, knowing N can determine the concentration C of object element because proportional relation is valid.

Measured degree of absorption for atomic absorption analysis is indicated by degree of normal absorbed light or percentage of transmission and defined by each (4), (5) formulas.

Degree of absorbed light

$$A = \log_{10} (I_{0\nu}/I_\nu) \dots\dots\dots (4)$$

Percentage of transmission

$$T (\%) = (I_\nu/I_{0\nu}) \times 100 \dots\dots\dots (5)$$

Because formula (1) is expressed as degree of absorbed light

$$A = 0.4353 K_{\nu} l \quad \dots\dots\dots(6)$$

When $K_{\max}$ is measured instead of measuring integral absorption coefficient.

$K_{\max}$ can be obtained by measuring degree of absorbed light A through

$$A = K_{\max} \cdot l \quad \dots\dots\dots(7)$$

The value that $K_{\max}$ is divided into concentration C of object atom in a sample is equivalent to atomic absorption of light E_{AA} and formula (7) is expressed as a

$$A = E_{AA} C l \quad \dots\dots\dots(8)$$

Because atomic absorption coefficient is characteristic integer of object atom, C can be obtained by measuring A when the E_{AA} is decided.

For analysis operation, draw graph of concentration and degree of absorbed light i.e measuring line by measuring about standard sample solution already knowing concentration. Then, obtain degree of absorbed light by measuring about sample that concentration is not known and read the concentration of sample from measuring line.

4. Equipment

4.1 A summary of equipment

Generally used atomic absorption analysis equipment is composed with the part of light source, the lower part of sample atom, a monochrome part and part measuring light and indicated at figure 1. Types are two of monochromatic speed type and multichromatic speed type.

Analyze flame using other parts except part of light source among the main constituent

parts indicated at figure 1 for flame luminescent analysis equipment.

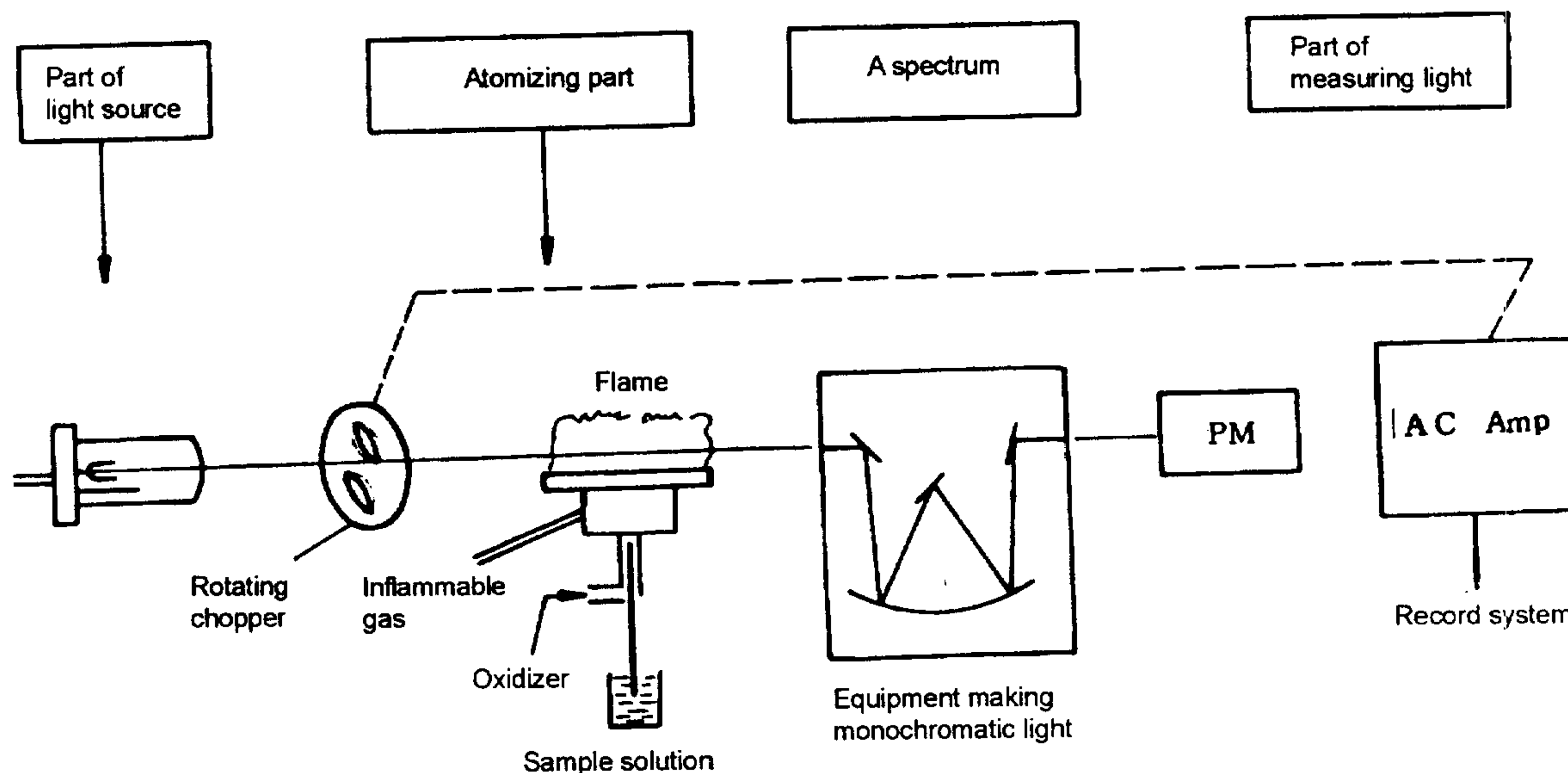


Figure 1 Diagram of structure of atomic absorption analysis equipment

4.2 Part of light source

4.2.1 Light source lamp

- Hollow cathod lamp-

Hollow cathod lamp (Figure 2) that has narrower line width than the one of atomic absorption spectrum line and radiate bright line spectrum of high brightness is usually used as light source for atomic absorption analysis.

Hollow cathod lamp has anode and cylinder shaped cathod in a glass tube that has a window made of glass or quartz with low pressure inert gas elements and cathod is made of alloy that has single element, object elements necessary to analyze or sintering alloy.

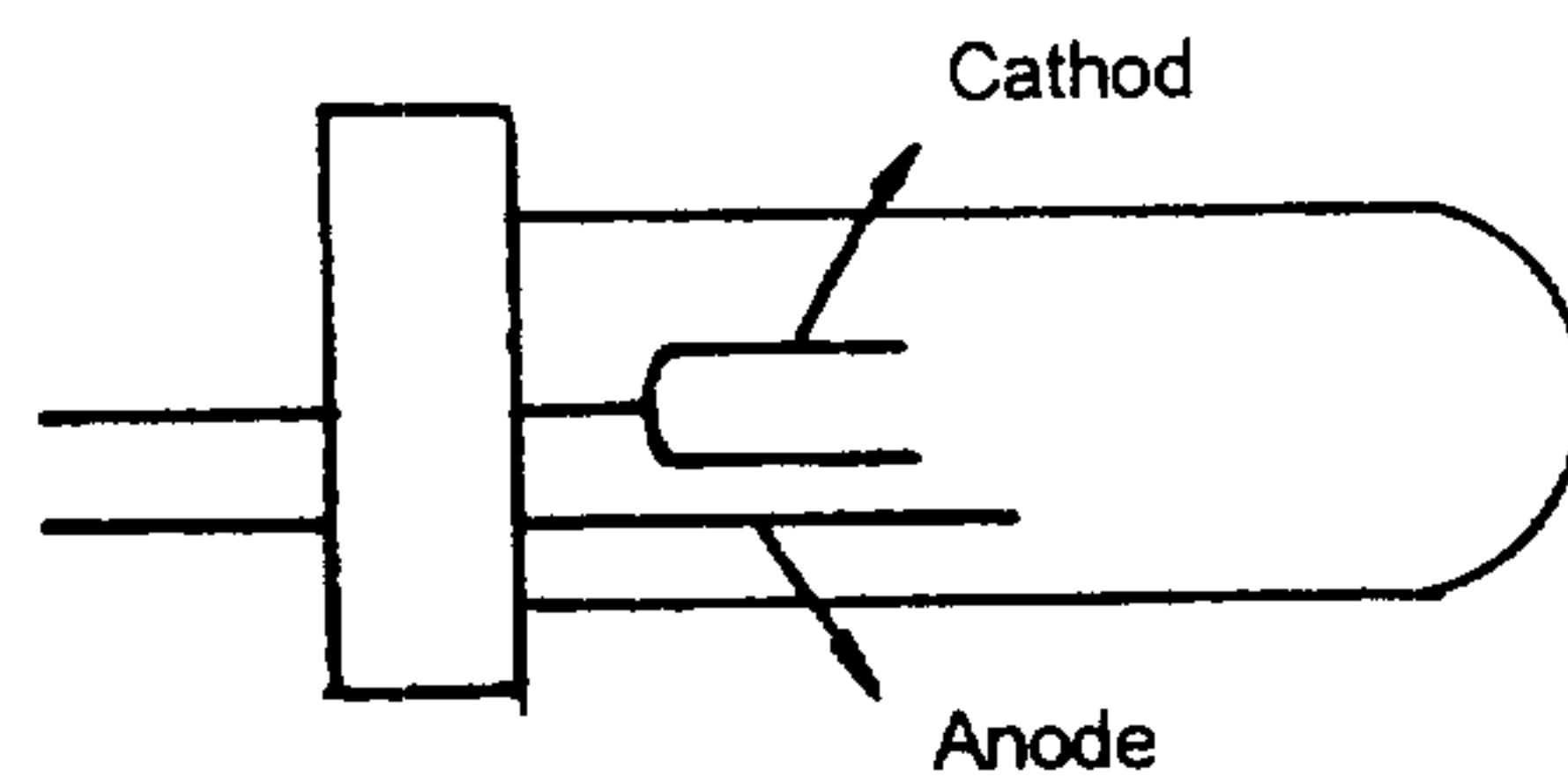


Figure 2. Diagram of structure of hollow cathode lamp

4.2.2 Lamp lighting equipment

There are DC lighting method and AC lighting method in methods of hollow cathode lamp. For DC lighting method, it is general that change light way by inserting light chopper between light source lamp and sample atomizing part, detect and amplify the only changed AC signal at side part of light and remove influence by luminescence of flame itself or sample.

For AC lighting method, light chopper is not necessary because light from light source is already changed. In both methods, as a lighting equipment of light source lamp following condition must have.

- (1) Static current or static voltage power circuit
- (2) Capable of control lamp current precisely
- (3) Preparation of pre-lighting circuit according to necessary lamp number

4.3 Sample atomizing part

Sample atomizing part consists of sample atomizing equipment for atomizing sample and optical system for transmitting light in atomic vapor.

4.3.1 Sample atomizing equipment

General method of atomizing sample is that atomize solution state sample by flame.

(1) Burner

This is all-atomizing burner that makes sample solution atomizing by vaporizing to