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Determination of the Photoelectric Properties for Ammonia Concentrations using USB-2000 Spectrometer

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ABSTRACT

Ammonia is an essential chemical raw material and it can be used as raw material and solutions for synthetic numerous organic compounds. Five samples of ammonia solutions were prepared in different concentrations (200, 150, 100, 50 and 7.5 mg/L), the solutions were subjected to spectrometer absorbance and transmission for wavelength between (340-540 nm) to determine the photoelectric properties of the ammonia solutions. The results showed that rapid increase of the absorption at 466 nm, compatible with the increase of photon energy, the effects of concentration on absorbance value increased with concentration decrease of absorbance values. rapid decrease in low energies and sudden decrease in special energies and it continuous with decrease at 466 nm, concentration increase refers to the decrease in transparent value. rapid increase in reflection values. The absorption coefficient (α) for all samples were found in the visible region, variation at the (K) values obtained in the visible region, meanwhile, the variation of (n) vs (λ) is revealed maximum value of (n) is (1.0022) for all samples at the same wavelength. the values of (Eg) obtained were 200 mg/L = 2.4996 eV, 150 mg/L = 2.4956 eV, 100 mg/L = 2.4929 eV, 50 mg/L = 2.4916 eV and 7.5 mg/L= 2.4902 eV. The value of (Eg) was decreased from (2.4996) eV to (2.4902) eV. The decreasing of (Eg) related to decrease in concentration.

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Introduction

Ammonia is a natural gas that is present throughout the atmosphere, it has pungent odor and colorless and lightest than air, it is known as toxic compound that can be harmful to the health if present at high concentration (Biorn timmer,2005). It's produce naturally in soil by bacteria decaying plant, as well as animals and human wastes. Although common on nature and in wide use, ammonia is both caustic and hazardous in its concentrated [1]. It's an essential chemical raw material [2]. Meanwhile, Ammonia can be used as a raw material for synthetic nitrogen fertilizer [3]. Additionally, it is a potential hydrogen storage material due to its high hydrogen content density (17.6 wt %) and ease of liquefaction [4-6]. Hydrogen produced by ammonia cracking can fuel vehicles directly [7]. Each ton of ammonia combustion can reduce 1.5 tons of Carbon dioxide emissions [8]. Ammonia has excellent performance in industrial engineering and agriculture, such as liquescence, storability (energy carriers), and transportation, and it has lower costs compared to hydrogen. Thus, ammonia is expected to be used as a vehicle fuel and fuel cell [9]. ammonia, produced by the Haber process, accounts for practically all the ammonia used industrially, it is used in the manufacture of nitric acid, urea, and nitrogenous fertilisers [10]. There are many ways to detect ammonia. High concentrations are easy to detect because the gas has a very penetrating odour. With respect to other odorous gasses, the human nose is very sensitive to ammonia. To quantify the ammonia concentration or determine lower concentrations of ammonia, the human nose fails. However, in many occasions, the ammonia concentration has to be known, even at ultra-low concentrations of less than parts per billion in air (ppb). [11].

In this manuscript, the preparation five samples of (NH3) by dissolving in distilled water in different concentrations. Then, solutions were subjected to spectrophotometer absorbance and transmition for wavelength between (340-540 nm) by using this type (USB-2000 Spectrometer). In order the to measure the photoelectric properties to the solutions.

Materials and Methods

5 g of ammonia dissolved in 1 liter of water, then take five different concentrations, the USB -2000 spectrometer connects to a notebook and desktop via USB port, when connected to the USB of port of a PC, the USB-2000 draws power from the host PC, eliminating the need for an external power supply.

Results and Discussion

Preparing five samples of (NH3) by dissolving in distilled water in different concentrations (200, 150, 100, 50 and 7.5 mg/L). Then measurements the optical properties by spectrophotometer absorbance and transmition for wavelength between (340 nm -540 nm) by using this type (USB -2000 Spectrophotometer). Figure 1 shows the relation between absorbance and wavelength; we found the behavior of curves is the same for each curve. The rapid increase of the absorption at 466 nm, these is referring to electronic transition, and this increase is continuous with the increase of photon energy, the effects of concentration on absorbance value increased with concentration decrease of absorbance value. Figure 2 shows the relation between transparent and wavelength, we had been found rapid decrease in low energies and sudden decrease in special energies and it continuous with decrease at 466 nm, concentration increase refers to the decrease in transparent value.

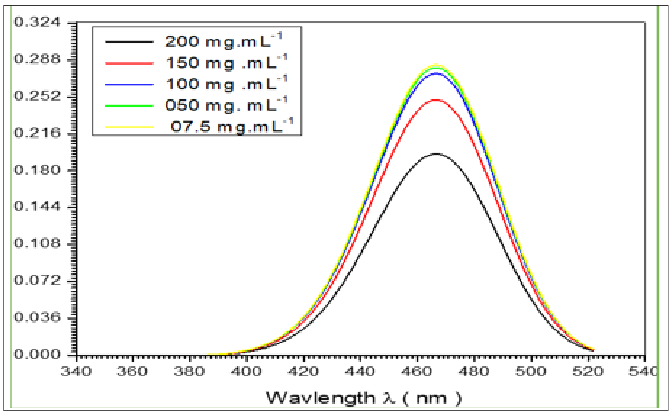

Figure 1: The Relation between Absorpance and Wavelength for Ammonia Concentrations.

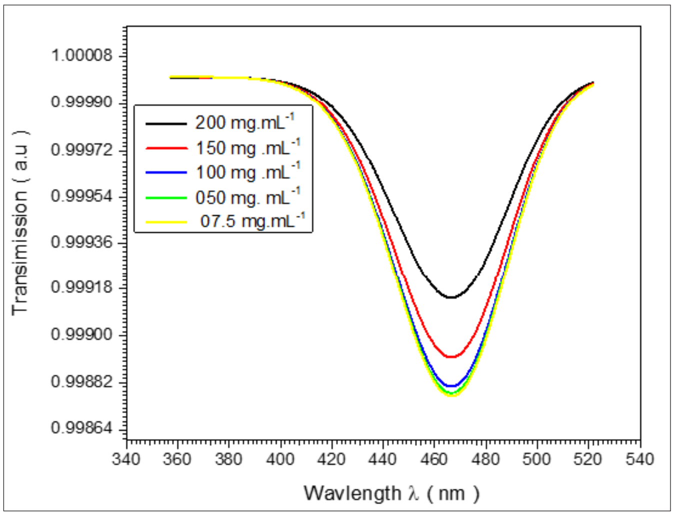

Figure 2: The Relation between Transparent and Wavelength for Ammonia Concentrations.

The reflection was calculated depended wavelength safe law using the relation:

R + T+ A = 1
When:
R: Reflection
T: Transmition

Figure 3 shows the relation between reflection and wavelength. we had been found rapid increase in reflection value until to arrive to peak, then it reduces from high wavelength because of less absorption in high wavelength transmition decreasing due to reflection increasing using the relation (1). At high energies from wavelength, the absorbance is increasing, this cause the reduce in reflection, and the upper corresponding wavelength value (466 nm). Increasing of concentration due to minor change in to peak curves, it is shifted low energies. The absorption coefficient (α) of (NH_3) by dissolving in distilled-water in different concentrations (200mg/L, 150 mg/L, 100 mg/L, 50 mg/L and 7.5 mg/L) were found from the following relation.

$$\alpha = 2.303\ A/t$$

where:
A: Is the absorbance and
t: is the optical length on the sample.

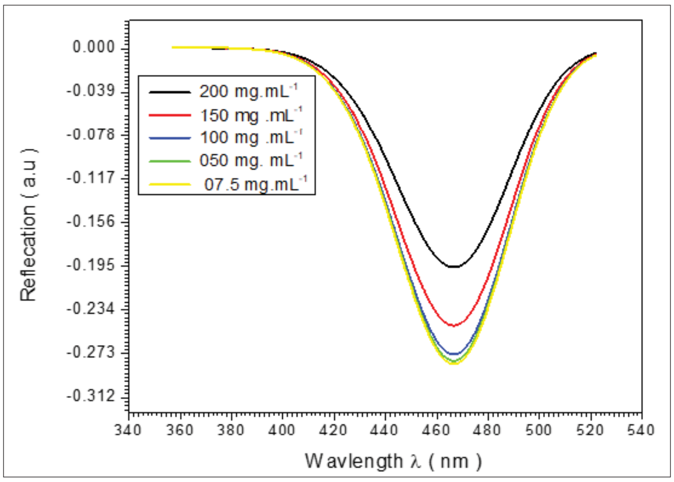

Figure 3: The Relation between Reflection and Wavelength for Ammonia Concentrations.

Figure 4 shows the plot of (α) with wavelength (λ), which obtained that the value of α >2.88×10^{-1} cm^{-1} for all samples in the visible region, this means that the transition must corresponding to a direct electronic transition, and the properties of this state are important, since they are responsible for electrical conduction. Also, fig.4 shows that the value of (α) for the sample 7.5 mg/L are greater than that 200 mg/L samples. Extinction coefficient (K) was calculated using the related.

$$K = \lambda\ \alpha / 4\ \pi$$

The variation at the (K) values as a function of (λ) are shown in Figure 5 It is observed that the spectrum shape of (K) as the same shape of (α). Figure 5 obtained the value of (K) at the visible region was depend on the samples treatment method, where the value of (K) at (466) nm for sample 7.5 mg/L is (10^{-7}) while for 150 mg/L at the same wavelength equal (9.3×10^{-8}) and 200 mg/L equal to (7.3×10^{-8}) at the same wavelength, this difference in (K) value become smaller at (400 and 520 nm). The refractive index (n) is the relative between speed of light in vacuum to its speed in material which does not absorb this light. The value of n was calculated from the equation:

$$n = \left[\left(\frac{1+R}{1-R}\right)^2 - \left(1-k^2\right) \right]^{\frac{1}{2}} + \frac{1+R}{1-R}$$

Where (R) is the reflectivity. The variation of (n) vs (λ) is shown in Fig.6 which shows that the maximum value of (n) is (1.0022) for all samples at the same wavelength. Also, we can show that the value of (n) begin to increase in the region of spectrum while (K) in its region became constant (466 nm). Also (n) value decrease with concentration decrease, this means that the samples become more transparent in the (466 nm) (VIS) region. The optical energy gap (Eg) has been calculated by the relation.

$$(\alpha h\upsilon)\ 2 = C\ (h\upsilon - Eg)$$

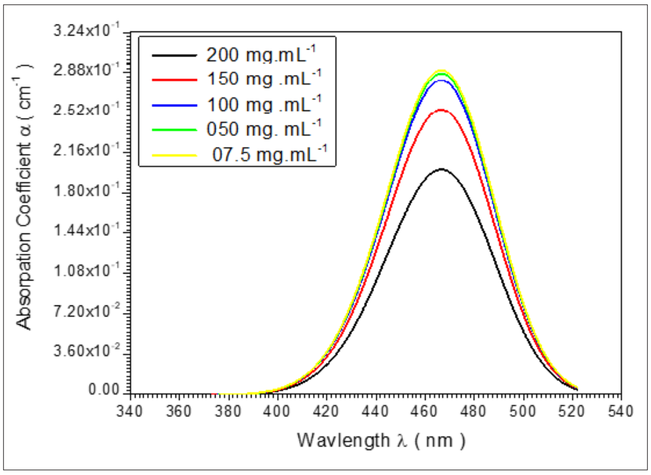

Figure 4: The Plot of (α) with Wavelength (λ) for Ammonia Concentrations.

where (C) is constant. By plotting $(\alpha h\upsilon)2$ vs photon energy $(h\upsilon)$ as shown in Fig.7 And by extrapolating the straight thin portion of the curve to intercept the energy axis, the value of the energy gap has been calculated. the value of (Eg) obtained was 200 mg/L = 2.4996 eV, 150 mg/L = 2.4956 eV, 100 mg/L = 2.4929 eV, 50 mg/L = 2.4916 eV and 7.5 mg/L= 2.4902 eV. The value of (Eg) was decreased from (2.4996) eV to (2.4902) eV. The decreasing of (Eg) related to decrease in concentration [12].

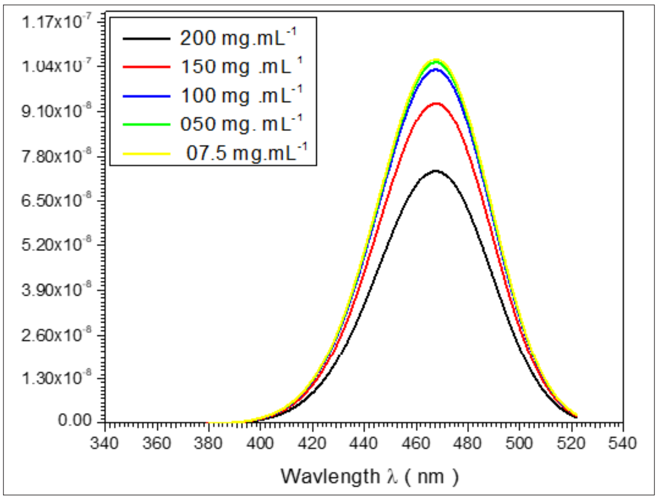

Figure 5: The Variation of Extinction Coefficient (K) with Wavelength (λ) for (NH3) Concentrations.

Conclusion

In conclusion, this study reports that rapid increase of the absorption at 466 nm, compatible with the increase of photon energy, the effect of concentrations on absorbance value increased with concentration decrease of absorbance values. rapid decrease in low energies and sudden decrease in special energies and it continuous with decrease at 466 nm, concentration increase refers to the decrease in transparent value. rapid increase in reflection values. The absorption coefficient (α) for all samples were found in the visible region, variation at the (K) values obtained in the visible region, meanwhile, the variation of (n) vs (λ) is revealed maximum value of (n) is (1.0022) for all samples at the same wavelength. the values of (Eg) obtained were decrease with increase of concentrations.

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Disclosure Statement Conflict of Interests

The authors declare that they have no conflict-of-interest Author contributions: All authors contributed equally to this work. Ethical approval: All ethical guidelines have been adhered.

References

1. Troy H, Karl C, Anthony JK (2013) Direct measurement of ammonia in simulated human breath using an inkjet-printed polyaniline nanoparticle sensor. Anal Chim Acta 779: 56-63.
2. Matthias P, Gregor S, Ron HP, Timothy GW, Martin JA, et al. (2018) Optimal energy supply structures for industrial food processing sites in different countries considering energy transitions. Energy 146: 112-123.
3. Jianping G, Ping C (2017) NH3 as an energy carrier, Chem. Catalysis 3: 709-712.
4. Joshua WM, Teng H, Claudia W, Torben RJ, Fei C, et al. (2019) Reversible ammonia–based and liquid organic hydrogen carriers for high–density hydrogen storage: recent progress. Int J Hydrogen Energy 44: 7746-7767.
5. Sunita S, John P, Carole R, George T, Grace O (2007) The U.S. Department of energy's national hydrogen storage project: progress towards meeting hydrogen-powered vehicle requirements. Catalysis Today 120: 246-256.
6. Kyriakou V, Garagounis I, Vasileiou E, Vourros A, Stoukides M (2017) Progress in the electrochemical synthesis of ammonia. Catalysis Today 286: 2-13.
7. Huazhang L (2014) Ammonia synthesis catalyst 100 years: Practice, enlightenment and challenge. Chin J Catalysis 35: 1619-1640.
8. Lin Y, Richard NL, René BA, Edman T (2017) Reaction: "Green" ammonia production. Chem A Cell Press Journal 3: 712-714.
9. Chengliang M, Linghao Y, Jie L, Jincai Z, Lizhi Z (2018) Energy–confined solar thermal ammonia synthesis with K/Ru/TiO2-xHx. Appl Catal B Environ 224: 612-620.
10. Liptrot GF (1983) Modern inorganic chemistry. Collins Educational; 4th edition 250-251.
11. Erisman JW, Otjes R, Hensen A, Jongejan P, Bulk Pvd, et al. (2001) Slanina, Instrument development and ap plication in studies and monitoring of ambient ammonia, Atmos. Environ 35: 1913-1922.
12. Björn T, Wouter O, Albert van den Berg (2005) Ammonia sensor and their application are view. Sensors and Actuators B: Chemical 107: 666-677.