Int. J. of Environmental Pollution & Environmental Modelling, Vol. 2(1): 44-47 (2019)
(Short Paper)

Application of Raman Spectroscopy to Pollution Control Using Wave Numbers

C. Ganesa Moorthy[1*]

[1]Department of Mathematics, Alagappa University, Karaikudi- 630003, India.

E-mail: *gmoorthyc@alagappauniversity.ac.in*

Abstract: Theory to apply Raman spectroscopy and infra red emission spectroscopy for pollution control has been presented. This theory applies wave numbers with strong intensities obtained in outputs of these two spectroscopy methods to find energies required to decompose materials. It has been suggested that this theory should be applied as a quality checking in production of materials to control pollution over materials which need decomposition.
Keywords: Wave numbers; Planck's equation; Wien's displacement law.

INTRODUCTION

There are many applications for nanoparticles, because there are many behavioral changes for nanoparticles relative to original materials; like changes in super conductivity, super capacity, magnetism, strength, specific heat etc. There are many methods and steps for synthesis of nanoparticles. One among them is giving heat energy to original materials with an expectation of making fine particles. Our aim is not to propose a method to decompose waste materials by means of natural heat energy with a time bound, because many plastic wastes are found in land, rivers and oceans, these wastes are subjected to natural heat energy, and there is a failure in decomposing them. Our aim is to make quality verification in production of plastic-like materials for good decomposition, before they come to applications. Nanoparticles are subjected to many tests for characterizations of the nanoparticles. Two fundamental tests are Raman spectroscopy and infra red emission spectroscopy. See [2, 11, 12]. In both methods, materials are subjected to light wave energies as input energies, for characterizations. After receiving these energies the materials release energy light waves with different wavelengths. Numerical inverses of wavelengths are called wave numbers. Different wavelengths with high intensities are observed to plot a graph with axes to represent wave numbers and intensities, in which high intensities are plotted by means of peaks. These peaks at particular wave numbers are referred to specific characterizations, more often they are referred to presence of different types of elements which are present in the materials. All of them are parts of physical sciences. These methods of characterizations can be applied to pollution control. A theory for this purpose is presented in this note. Let us observe that pollution should be controlled by all methods and all theories as described in the articles [13, 14-22]. The theory presented in this note uses peaks in output graphs for wave numbers and intensities in Raman spectroscopy and infra red emission spectroscopy to find maximum energies required to decompose materials. These measurements can be used to take decisions in releasing materials into market, and thereby to get control over future pollution.

Theory

If a material releases energy by means of a light wave with wavelength λ, then let us consider this wavelength λ as a characteristic wavelength. For example, if an input laser is given to a sample material, then light rays may be emitted from the material with different wavelengths. See [2, 11]. One more example has been provided in the article [5], in which it is explained that light waves are released between two successive electrons moving in serial, when an electric current passes through a wire. The articles [4, 6-10, 22-27] may be found as articles which support and which are related to the article [5]. Theoretical explanations given in all these reference articles are not sufficient to explain amount of

[*]*Corresponding E-mail: gmoorthyc@alagappauniversity.ac.in*

energies required to induce emissions. However, there should be a maximum value and a minimum value for characteristic wavelengths. These limits decide certain aspects in decomposition of materials. Let us use the notations λ_{max} and λ_{min} for least upper bound and greatest lower bound for possible characteristic wavelengths of light waves that can be emitted from a material. By Planck's equation, $E = h\nu$, the corresponding minimum and maximum energies are $E_{min} = \frac{hc}{\lambda_{max}}$ and $E_{max} = \frac{hc}{\lambda_{min}}$. This means that one has to apply a minimum energy E_{min} to get emission of at least one wave with a particular wavelength, and one has to apply a sufficient energy E_{max} to get of all possible emissions of all wavelengths. Here h is the Planck's constant, c is the speed of light in vacuum, and ν is the frequency. Let us discuss a different interpretation. If a material can naturally releases an energy light wave with wavelength λ, and if these waves with wavelength λ are not permitted to get released, then one expected change in the material is a break in the bonds of molecules, which may lead to decomposition of the material. On the other hand, if a material can release an energy light wave with wavelength λ, and if an outside input light energy through light waves with wavelength λ is given to the material, then decomposition is expected. If any energy greater than E_{max} is given as input, then again decomposition is expected. For these conclusions, there is a need to provide many explanations for Planck's equation.

The classical meaning of the energy E in the Planck's equation $E = h\nu$ is the energy of one photon of a light wave with wavelength $\frac{c}{\nu}$. However, E represents in the book [3] that the energy of ν- number of photons, or equivalently, h represents an energy of a single photon (or of a double photon in view of interference). Let us follow this special meaning of h as energy for a single photon in a single light wave ray. This means that Erepresents energy released by any single light wave ray with wavelength $\frac{c}{\nu}$, when it strikes a body for one second. Here, second is considered as a unit for time. Apart from this interpretation of single ray energy considered for input energy, one should take volume, mass and specific heat of a material into consideration, for decomposition. In that case, time of applying energy light waves should be increased, when energy light waves applied have at least energy E_{max} and at most wavelength λ_{min}.

If input energy is supplied by means of microwaves, then energy of a single wave for one second collision can be evaluated by the formula $E = m_e v^2$, when m_e is the mass of an electron, and v is the velocity of electrons moving in the microwave. This formula, which is similar to Einstein's energy-mass relation, can be justified by means of a final interpretation given in the article [7]. This energy should be greater than or equal to E_{max}. Thus, one can determine required velocity v to decompose a material for which λ_{min} is known. Again, time required for applying this type of microwaves for decomposition depends on volume, mass, specific heat and capacity of the material to observe microwaves.

The fundamental methods, Raman spectroscopy and infra red emission spectroscopy (see [2,11,12]) can be used to find all possible wavelengths with intensities of emitted waves by means of peaks, and a minimum possible wavelength of emitted rays in these methods may be considered approximately as λ_{min}. That is, wavelengths corresponding to wave numbers for which peaks appear are considered, the minimum of these wavelengths corresponding to peaks is considered as λ_{min}, and then $E_{max} = \frac{hc}{\lambda_{min}}$ can be calculated. It should be observed that any wavelength λ corresponding to any peak corresponds to wave energy $E = \frac{hc}{\lambda}$, which is also sufficient to decompose materials, but partly. Complete decomposition can be expected only for E_{max}.

CONCLUSIONS

Spectroscopy methods like Raman spectroscopy, infra red emission spectroscopy can be used to find wave energy E_{max} required for assured decomposition. The main difficulty is to find a method to determine the time required for decomposition, because the existing theories do not facilitate this computation. If an environment can give only a light wave of an average wavelength λ_{env}, then materials to be decomposed in that environment should be produced only with λ_{min} greater than or equal to λ_{env}. Such a quality checking in production of materials can control future-pollution, which may be occured by materials in that environment. To find λ_{env}, one may use the Wien's displacement law, approximately, as $\lambda_{env} = \frac{b}{T}$, where b is the Wien's constant involved in Wien's displacement law, and T is the average temperature of the environment. Further simplification is carried out in the continuation part "Applications" directly through wave numbers. In this way, theory mentioned above is completely applicable for materials when spectroscopy methods are used.

APPLICATIONS

Let us consider the output graph obtained by means of Raman spectroscopy for a fiber material given in Figure 2.10 in the book [11]. The highest wave number with a high intensity in that figure is approximately 1730 cm^{-1}. If this number is considered as inverse of λ_{min}, and if λ_{env} is replaced by λ_{min}, then we obtain $T = b \times 1730\ cm^{-1}$, where $b = 0.28978\ cm^{-1}K$. For this specific wave number 1730 cm^{-1}, the value of T is approximately, 501.3194 Kelvin. This means that to decompose that material *completely* nearly a heat exposure of 501.3194 Kelvin is sufficient. In general, if there is a wave number w with an intensity peak, then the temperature $T = b \times w$ is enough to decompose the material *partially*. This provides a most simplified formula for application of the theory developed above. On the other hand, if temperature is fixed then our expected wave number for decomposition can be determined. For example, if a partial decomposition of a material is expected in the temperatures, 303 Kelvin, 313 Kelvin, 323 Kelvin, it is sufficient if there are wave numbers which are less than 1045.6 cm^{-1}, 1080.1 cm^{-1}, 1114.6 cm^{-1}, respectively, which can be calculated by the formula $T = b \times w$.

Let us consider another output graph obtained by means of infra red emission spectroscopy for a PE film material given in Figure 3(b) in the article [1]. There is a peak at the wave number 3000 cm^{-1}. By the formula $T = b \times w$, it can be concluded that at least 870 Kelvin is required for a complete decomposition. There is another peak nearly at the wave number 700 cm^{-1} in that figure. Then, by the same formula, it can be concluded that nearly 203 Kelvin is sufficient for a partial decomposition, but not for a complete decomposition. It should be again mentioned that time required for decomposition in evaluated temperature is yet to be predicted, because there many factors related to thermal energy are involved in such a prediction. It should also be observed that a material may be decomposed due to many factors apart from heat energy.

REFERENCES

[1] Fujioka, Y. Infrared Emission Spectroscopy and Its Application to Analyze Non-smooth Metallic Materials Surface.

[2] Long, D. A. (2002). The raman effect. Wiley.

[3] Moorthy, C. Ganesa; Sankar, G. Udhaya. (2018). Planets And Electromagnetic waves. Idea Publishing, 1-110

[4] Moorthy, C. G., Sankar, G. U., & RajKumar, G. (2017). A Design for Charging Section of Electrostatic Precipitators by Applying a Law for Electric Field Waves. Imperial Journal of Interdisciplinary Research, 3(6).

[5] Moorthy, C. G., Sankar, G. U., & Rajkumar, G. (2017). Two Expressions for Electrostatic Forces and For Magnetic Forces to Classify Electromagnetic Waves. Imperial Journal of Interdisciplinary Research, 3(10).

[6] Moorthy, C. G., Sankar, G. U., & RajKumar, G. (2017). LIGOs Detected Magnetic Field Waves; not Gravitational Waves. Imperial Journal of Interdisciplinary Research, 3(8).

[7] Moorthy, C. G., Sankar, G., & Rajkumar, G. (2017). Simplified Interpretation for Einstein's Energy Mass Relation. Imperial Journal of Interdisciplinary Research.

[8] Moorthy, C. G., Sankar, G. U., & RajKumar, G. (2018). Temperature of Black Holes and Minimum Wavelength of Radio Waves.

[9] Moorthy, C. Ganesa, G. Udhaya Sankar, and Graj Kumar. "What Is The Polarity Of An Electromagnetic Wave?." Indian J. Sci. Res 13.1 (2017): 255-256.

[10] RajKumar, G., Moorthy, C. G., & Sekar, S. (2018). New Design for Charging Section of Electrostatic Precipitators Using Thermocouple Principle for Air Pollution Control. Int. J. of Environmental Pollution & Environmental Modelling, 1(4), 116-119.
[11] Ewen, S., & Geoffrey, D. (2005). Modern Raman spectroscopy: a practical approach. New York: John Wiler & Sons.
[12] Stuart, B. H. (2004). Experimental methods. Infrared Spectroscopy: Fundamentals and Applications; John Wiley & Sons: Hoboken, NJ, USA, 18-19.
[13] Tsuchida, A., Kawazumi, H., Kazuyoshi, A., & Yasuo, T. (2009, October). Identification of shredded plastics in milliseconds using Raman spectroscopy for recycling. In SENSORS, 2009 IEEE (pp. 1473-1476). IEEE.
[14] Ayturan, Y. A., Öztürk, A., & Ayturan, Z. C. (2017). Modelling of PM10 Pollution in Karatay District of Konya with Artificial Neural Networks. Journal of International Environmental Application and Science, 12(3), 256-263.
[15] Udhaya Sankar, G., Ganesa Moorthy, C., & RajKumar, G. (2018). Synthesizing graphene from waste mosquito repellent graphite rod by using electrochemical exfoliation for battery/supercapacitor applications. Energy Sources, Part A: Recovery, Utilization, and Environmental Effects, 40(10), 1209-1214.
[16] Moorthy, C. G., Sankar, G. U., & Rajkumar, G. (2016). Rotating Bodies Do Have Magnetic Field.
[17] Ayturan, Y., Ayturan, Z., & Altun, H. (2018). Air Pollution Modelling with Deep Learning: A Review. International Journal of Environmental Pollution and Environmental Modelling, 1(3), 58-62.
[18] Udhaya Sankar, G., Ganesa Moorthy, C., & RajKumar, G. (2018). A suggestion for a good anode material synthesized and characterized. Discov, 54, 249-253.
[19] Sankar, G. U. (2016). Climate change challenge–photosynthesis vs. hydro-electrolysis principle. Climate Change, 3, 128-131.
[20] Udhaya Sankar, G., Ganesa Moorthy, C., & RajKumar, G. (2019). Smart Storage Systems for Electric Vehicles–A Review. Smart Science, 7(1), 1-15.
[21] Vallikkodi, M., Sankar, G. U., & Vishnukumar, P. (2017). An Innovative Interpretation for Parallel Universe. Imperial Journal of Interdisciplinary Research, 3(5).
[22] MOORTHY, C. G., SANKAR, G. U., & KUMAR, G. A VELOCITY INDEX FOR EXISTENCE OF ATMOSPHERE IN A PLANET. Mercury, 4(47.4), 10-8937.
[23] Moorthy, C. G., Sankar, G. U., & Kumar, G. R. Why Do Distant Planets Have Speedy Winds?. Mercury, 3, 0-24055556.
[24] G.udhaya sankar, (2007). A Survey on Wavelength Based Application of Ultraviolet LED, computing.
[25] Moorthy, G., & Raj, I. (2013). Weak convergence of fixed point iterations in metric spaces. Journal of Nonlinear Analysis and Optimization: Theory & Applications, 4(2), 189-192.
[26] Moorthy, C. G. (1992). A problem of Good on Hausdorff dimension. Mathematika, 39(2), 244-246.
[27] Marikkannan, N., & Ganesamoorthy, C. (2008). On applications of differential subordination and superordination. Tamkang Journal of Mathematics, 39(2), 155-164.