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At present, rapid urbanization, motorization, industrialization and population growth contributes to a growing air pollution problem in developing urban centers. The degradation of air quality is a major environmental problem that affects many urban and industrial sites and the surrounding regions worldwide. Urbanization and high levels of vehicle emission is correlated with the increasing frequency of aerosol-induced allergic symptoms and people who live in urban areas tend to be more affected by aerosol-induced respiratory allergy than those of rural areas.

Aerosols are very fine particles present in our Environment from nanometer to micrometer range. These particles are abundant in nature and play an important role in visibility, air pollution, regional and global meteorology. Aerosols are of central importance for physics and chemistry of the atmosphere, the biosphere, climate, and public health. Aerosols influence the energy balance of the Earth, the hydrological cycle, and atmospheric circulation.

Aerosol loading is expected to have an additional reflection, which affects the climate comparative to the increasing concentrations of atmospheric gases. Therefore, it is necessary to have accurate physical and chemical identification of these aerosols. Aerosols can also be used as tracers to study how the Earth's atmosphere moves because aerosols change their characteristics very slowly. They make much better tracers for atmospheric motions than a chemical species that may vary its concentration through chemical reactions. The effect of the aerosols will be opposite to the effect of trace gases - cooling instead of warming the atmosphere.

The physical part includes the determination of particle concentration, particle size distribution, microstructure of particles and the measurement of pressure, temperature and relative humidity. The chemical characterization includes the characterization of the gas phase, chemical composition of the collective particulate matter and chemical composition of a single particle. The increasing importance of
aerosols for understanding the environmental processes, public health as well as the use of aerosol technologies has led to a great interest in aerosol characterization. In order to study the formation mechanisms and understand the subsequent chemical transformation in various conditions, an analytical method, Raman spectroscopy has been utilized by the author for the present study. It is a very versatile tool for chemical characterization of these particles. It is a novel technique for chemical analysis of aerosol particles as well as solution droplets. This technique is capable of providing chemical identification of most compounds with low sensitivity. Typical Raman cross sections for solids and liquids can be more than 6 orders of magnitude smaller than those in the infrared, so obtaining the Raman spectrum of an aerosol is a significant experimental challenge.

Raman spectroscopy provides valuable structural information about materials. When laser light is incident upon a sample, a small percentage of the scattered light may be shifted in frequency. The frequency shift of the Raman scattered light is directly related to the structural properties of the material. A Raman spectrum provides information that is unique to the material. A Raman signature provides the material identification of unknown specimens without destruction to a level that is unmatched by other spectroscopic methods. The aerosols from the chemical reactions point of view are needed to study. The molecular structure of aerosol is not yet studied fully, as most of the systems are destructive methods. Hence it is proposed to study aerosol configuration using Raman Spectrometer.

The dissertation is divided into SIX chapters. The highlights of each chapter are given below.

The general information of atmospheric aerosols, about their sources, how they are pumped into the atmosphere and their sinks is discussed in Chapter one. Aerosols are classified by types, properties and their transformations during their stay in the atmosphere with the more focus on their chemical properties. Aerosol composition, their transformations and removal processes play an important role in the atmosphere. The various properties are discussed in detail with more emphasis on chemical properties. The role of aerosols in different atmospheric issues, such as impact on weather and climate; radiation budget as they scatter and absorb solar radiation or act as nuclei for formation
of clouds. The main emphasis is given to the effects of aerosols on human health. The review of previous work done, the development of different techniques related with lasers and the importance of analytical technique like Raman Spectroscopy for the study of chemical properties is given.

Chapter two gives details about history and theory of Raman Spectroscopy. It mainly explains the Raman principle, spectrometer technology and interpretation of the Raman signals. The repair and upgradation of the Laser system as well as the monochromators is discussed with the reinstallation of the Raman Spectrometer System. The detailed instrumental information of Raman Spectrometer setup is given in this chapter. Both types of lasers, polarizer, detector and monochromator part is explained with the necessary figures and photographs. All the needed accessories and the data acquisition system are described in this chapter.

Design and development of the accessories to be used in the Raman Spectrometer is discussed in chapter three. The conventional sample collecting system in use requires 24 hrs to 48 hrs for one sample. In the field the samples are collected on Quartz micro fiber filter paper with the conventional suction pump. The household vacuum cleaner is attempted to enhance the fast sample collection. It is possible to collect the samples within 1-2 hrs using this newly developed sample collector. The approach and underlying principle are discussed with diagrams and the supportive information. This modified sample collector achieves the considerable speed in sample collection. The review and theory of the calibration methods is also given in this chapter. This instrument is realigned by using the mercury light and then the PMT, which is used as detector is tested for voltage stabilization and cooling for better signal to noise ratio. Finally it is calibrated using the neon light source with necessary precautions, results with graphs are given. The alignment of the external optics for different lasers is shown and discussed. The experimental parameter setting and the actual experimental procedure controlled by data acquisition system are also given.
The results of samples collected from different sites are discussed in Chapter four. The selection of sites justified with the atmospheric conditions and the purpose is given. The first observational site is at the campus of Indian Institute of Tropical Meteorology (IITM), where the instrument is installed is a semi urban location. The results have shown few spatial variations in the results from the samples collected. The Raman shifts were dominated by the components of carbon due to exhausts of vehicular activities, as the site is near to the busy traffic road. The other sites are rural areas. One is at Rahuri, which is near to the Sugar factory and other is at Srirampur where the samples were collected near the wheat farm before and after the sprinkling of pesticides. This study has been carried out to understand the addition of these pollutants on aerosol signatures in the environment. The fourth site is Sinhgad, a high altitude and rural location with clean environment. This is an important location to compare the results with the rural and urban results. At this site we collected the samples round the clock for two days. The Raman Spectrum for the different samples obtained from these sites were analyzed and interpreted.

Chapter five consists of an important part of the Raman spectroscopic study. The pollen grains are separately studied as a concern that they are integral part of the atmosphere. These pollens are very hazardous to human health in many ways. The details about the pollen importance and their effects are given in detail. Raman analysis for some of the aerosol samples has been carried out by heating. The sample is heated for an hour each at 1000 C, 2000 C and 3000 C to compare with the spectrum of original sample. At 1000 C it is found that the organic components from the samples drastically reduced in the Raman Shift spectrum. And at higher temperature the Raman Spectrum remains almost unchanged. Comparative discussion of the results for the all four sites, conclusions and a databank of all Raman Shift signals are given in this chapter.

In Chapter Six, the summary of the research work carried out, conclusions and future scope of the study is presented. The results indicate that this technique is capable of determining useful chemical information about ambient aerosols. The most intense Raman spectrum detected in the samples was that of Carbon compounds, which exhibited
band shapes characteristic. Many samples also had compound characteristics of sulfate, nitrate and other inorganic components. Some samples indicated the presence of halogen compounds of methyl group such as CH$_3$Br, CH$_2$ and CH$_3$ groups were detected at 2837, 2998 and 1466 cm$^{-1}$ respectively. Benzene ring presence appears at 2002 cm$^{-1}$ in few samples.

The future work is mainly the development of the Data acquisition system for Raman Spectrometer. An attempt has been made for the up gradation of present data acquisition system by replacing it with new advanced PC based system. This up gradation and the new air-cooled laser will make the instrument compact and more efficient for the future studies. A brief description about the work done on the design of the controller and the outline of the software to be used in the development of new Data Acquisition System is given.

Santosh Hanmantrao Kulkarni