the rectification, till we reach the stage of zero oxygen atom associated with a crystallite. This is of course the stage when we have pure Cu_2O which, as is well known, is not a rectifier. It is significant that when we succeed in removing all the oxygen from the rectifier film by suitable heat treatment, the substance is no longer a rectifier, and the crystal structure as shown by electron diffraction changes back from the zinc blende pattern to the normal Cu_2O pattern.

AIR POLLUTION IN RELATION TO PLANT DISEASES

THE Presidential Address of Dr. S. N. Das Gupta to the Section of Botany* dealt with the present status of researches on air pollution in relation to plant diseases, and a brief reference was made to certain aspects of the problems in India which assume special significance in view of the increasing threat of air pollution from programmes of industrial expansion launched under the two successive Five-Year Plans.

Consumption of fuels (specially coal) and other raw materials in industrial plants results in the discharge of smoke and other effluents into the atmosphere causing air pollution. The more important pollutants are sulphur dioxide, fluorine, ethylene, illuminant gas, carbon monoxide, hydrogen chloride, hydrogen sulphide, oxides of nitrogen, unsaturated hydrocarbon, soot and tar in various proportions depending upon the source materials. These are present in the atmosphere in three different phases: (1) gaseous phase, (2) aerosol phase (0·01-50 μ), and (3) particulate matter. Of these the gas phase is more common and is the usual toxic phase.

Air pollution is most acute in industrial towns and larger cities. Normally diluted by air current the effluents spread out but under certain meteorological conditions these remain suspended in the atmosphere and attain a concentration which is toxic even in short exposures. Apart from slow poisoning, some of these gases in excessive doses produce acute respiratory trouble in man causing death. Animals also are affected. Effluents in high dose are known to have destroyed vegetation. Some of the pollutants can affect the plants at an infinitesimal dose (1 part in a million and even less). Often these minute doses cause only epinastic or similar reactions and for severe injury (lesions) higher doses are required.

Each gas evokes a characteristic syndrome in plants, but under certain conditions depending upon the species affected and the growth environment, the symptoms become more or less indistinguishable. The gases cause injury to wide variety of plants belonging to the various taxonomic groups, and of different habit and growth form. These include, among others, conifers, spruce, fir, larch, elm, poplar, cedar; mango, banana, citrus, grape, apple, peach, plum and other fruit trees; tomato, potato, brinjal, carrot, bean, radish, sweetpeas, cucumber, lettuce and other vegetables; many ornamental plants like rose, marigold and gladiolus; and also such economic crops as wheat, barley, oat, rye, corn and cotton.

While species differ in susceptibility, the varieties within a species also show difference in susceptibility. The reaction of each species and variety is different in reference to the type of gas employed. For example, alfalfa which is most susceptible to sulphur dioxide is not equally susceptible to fluorine; it is gladiolus which is most sensitive to fluorine. The plants on the basis of their reactions to gas-exposure under controlled conditions can be arranged in order of their susceptibility to a particular gas.

The incidence and extent of air pollution injury to plants are conditioned by the concentration of the toxic agent in the atmosphere, the maturity and the nutritional state of the exposed plants and environmental conditions like temperature, light, soil, moisture, etc.

The susceptibility to disease has been correlated with the condition of the stomata through which the gases enter the leaf tissue. Physiological factors regulating stomatal movements also govern susceptibility of individual plants. Generally speaking, young, vigorously-growing and highly functional leaves are most susceptible, followed by older ones, and most resistant are the youngest leaves. Plants that close stomata in night are more resistant at night than in the daytime. Plants in which stomata are always open (*e.g.*, potato) are equally susceptible in day and night. Plants fully turgid are more susceptible. The near-wilting condition induces resistance. Resistance is high at a temperature below 40° F. and sometimes above 100° F. Sublethal concentration of sulphur dioxide and other gases has no

* At the 44th Session of the Indian Science Congress, January 1957.

harmful effect even on long exposure, except in smog which retards the growth by affecting metabolic processes.

Symptoms resulting from air pollution often simulate those caused by viruses, bacteria, fungi, insects, nutritional unbalance and other physiogenic disorders. Symptomatological evidence, therefore, needs corroboration by other more objective analytical techniques. Precise diagnosis of the distribution and degree of injury is difficult unless some knowledge is available of the character and intensity of gas visitations, the meteorological conditions, the chemical composition of the affected plant tissues, and the reaction of susceptible indicator plants. In diagnosing symptoms arising in a given smoke-pervaded region, the possible agency of several gases detected in the region is to be taken into account.

Differential reaction of test plants sensitive to the various air pollutants can be employed to detect the specific injury causing substances in the atmosphere and it may even be possible to utilise this technique for making a fair surmise of the pollutant concentration present there. Chemical analysis of diseased tissues, though it may confirm the findings from other methods, cannot be used as a sole criterion unless tolerance value of each plant is known; this leads to the experimental production of the disease by suitable gas exposure. Physical techniques, though of limited value, have also been employed in the diagnosis of gas injury in plants. For example, smog injury may be assessed from the characteristic bright pale blue fluorescence of smog marked areas irradiated with near ultraviolet light.

The ultimate solution of air pollution problems can only come about through co-operative endeavour from diverse fields as also legislative action. Technologists and industrial designers must co-operate in controlling the pollutants at their very source, while botanical research in the various branches such as the pathology, physiology, ecology and genetics of plants is also needed in assessing the extent of vegetation damage through air pollution and devising suitable remedies for combating it.

'SCIENCE IN THE SERVICE OF INDUSTRY' EXHIBITION

THE Science Exhibition organized by the Council of Scientific and Industrial Research as one of the series of educational, scientific and cultural exhibitions in connection with the Ninth General Conference of UNESCO held at New Delhi was inaugurated by the Vice President of India on 8 November 1956. The exhibition was open to the public from 11 November to 5 December.

Twenty-two prominent research institutions, including the National Laboratories, participated in the exhibition. The exhibits numbering about 300 were displayed in a well-planned pavilion with a floor space of 18,000 sq. ft. Surveys of raw material resources of the country, evolution of substitutes and alternatives for materials which are imported or scarce, processing and beneficiation of raw materials, utilization of waste products and by-products of industry, and development of improved processes of manufacture were some of the themes covered. Arrangements had been made for the demonstration of the technical processes developed in the laboratories.

A variety of instruments and testing equipment developed in the research laboratories, *e.g.*, primary time and frequency standard including a quartz clock, Finch-type electron diffraction camera, a new primary wet cell system, conducting sheet analogue computer, simultaneous intercommunication unit, ultrasonic tester for testing concrete carte wheel tester, equipment for strain measurement, apparatus used in radioactive tracer studies, etc., were on display.

This exhibition is perhaps the first attempt made in India to display the results of research on a comprehensive scale and in a manner designed to convey precise information to idustrialists, students of science and technology and others. It has succeeded in a great measure, in demonstrating that science in India has acquired both direction and purpose. Much thought, labour and time had been spent in organizing the exhibition which has fully served the dual purpose of furthering liaison between research and industry and scientific education.
