Symposium Focuses on the Effect of Acid Rain on Materials

The symposium on the Degradation of Materials Due to Acid Rain, held on June 17-18, 1985, in Arlington, Virginia, addressed the materials problems resulting from acid deposition. Thirty-nine papers explored five topical areas: Measurement and Monitoring of Atmospheric Deposition; Masonry Deterioration; Degradation of Organics; Metallic Corrosion; and Economic Effects.

The symposium was sponsored by the Division of Industrial and Engineering Chemistry of the American Chemical Society and co-sponsored by over a dozen materials oriented societies, including the Materials Research Society. Supporting organizations were the Electric Power Research Institute, National Acid Precipitation Assessment Program, and the National Science Foundation. The organizing committee was chaired by Robert Baboian of Texas Instruments.

Summary of Technical Sessions

The session, Measurement and Monitoring of Atmospheric Deposition, concentrated on the scope of the acid deposition problem and covered wet deposition chemistry, dry deposition, fog and cloud water, and the composition of dew.

The Masonry Deterioration session focused on the effects of acid deposition on structures such as buildings and monuments. Acids present in wet and dry deposition and gaseous sulfur dioxide (in the presence of surface moisture) are probably the most important agents causing deterioration of limestone and marble. It was reported that acid deposition attacks concrete in any combination of four ways: (1) by dissolving both hydrated and unhydrated cement components, (2) by dissolving calcareous aggregates, (3) through physical stresses induced by the deposition of soluble sulfate and nitrate salts and the subsequent formation of new solid phases within the pore structure, and (4) by salt-induced corrosion of reinforcing steel. The first two forms of attack are the major mechanisms of damage to ancient statues, and to monuments and buildings. Several mechanisms were related to the deterioration of brick masonry. Bricks are susceptible through the selective dissolution of their glassy phase. The mortar is affected mainly by the reaction of its calcareous components.

This session, Degradation of Organics, dealt with paints, plastics, nylon, wood, and architectural organics. Acid deposition on painted materials involves degradation of the coating and the substrates, but very little work has been conducted on the effect of acid deposition on the substrate/coating interface. This is, however, reported to be an important site of degradation. The discoloration or "frosting" of latex paints was reported to be caused by the concentration of sulfur dioxide, nitrogen oxide, or hydrogen sulfide pollutants. Strength losses in wood may be caused by hydrolytic degradation of the hemicelluloses and a sulfonation reaction of the lignin. Acid deposition on nylon shortens the potential service life for outdoor fabrics. Interestingly, light accelerates the attack of atmospheric sulfuric acid on nylon.

The strong program on Metallic Corrosion clearly indicated that the conventional classification of environments into marine, industrial, and rural is no longer adequate. In addition to corrosion of cultural resources such as bronze statues, the discussions covered the corrosion of automobiles, reinforcing steel, bridges and other architectural materials, and indoor equipment. The effect of acid deposition on the corrosion behavior of many specific steels and other materials was reported. The effects of certain enviroments were also addressed. The particularly severe automotive environment in the Northeast United States, for example, is due to the combination of acid deposition and the use of road de-icing salts.

The session, Economic Effects, reported on the methods used to assess the costs of materials degradation due to acid deposition, and on the difficulty in accurately assessing these costs. Also discussed was the response of manufacturers and householders to pollutant-induced damages. The economic costs are potentially huge, given the ubiquitous nature of exposed buildings, infrastructure components such as bridges and transmission towers, and cultural resources. The irreversibility of the damage is most important when considering cultural resources.

In the United States, costs of metallic corrosion associated with acid deposition were assessed at 0.15% of the GNP, or about $5 billion in 1984. Economic damages to building materials alone were estimated at $2 billion annually. Based upon this presentation, the annual cost of materials degradation by acid deposition in the United States is over $5 billion and could be as high as $25 billion.

Summary

While the Symposium provided much information on the wide range of materials affected by acid deposition, it became evident that there is much to be done regarding future research and funding. For example, only 2.5% of the budge of the National Acid Precipitation Assessment Program is directed toward the study of materials degradation. A better understanding of the nature and mechanisms of materials damage by acid deposition could reduce or even eliminate this type of damage, and would lead to huge annual dollar savings.

The Symposium proceedings will be published as a volume in the American Chemical Society Symposium Series.

32nd International Field Emission Symposium

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The 32nd International Field Emission Symposium (IFES) was held in Wheeling, West Virginia, July 14-19, 1985. The symposium was organized by Professor S. S. Brenner, Department of Metallurgical and Materials Engineering, University of Pittsburgh, Pennsylvania.

More than one half of the 83 papers presented at the 32nd IFES were devoted to materials science research and such topics as precipitation in alloys, including those aluminum, segregation of grain boundaries, precipitate interfaces and surfaces, local composition fluctuations in intermetallic and 3-5 semiconducting compounds, copper-induced radiation hardening in reactor steels, and atomic packing in icosahedral structures.

The main theme of the materials-oriented papers was the application of field ion microscopy (FIM) and atom probe microanalysis to the study of the atomic-scale structure and composition of materials. The usefulness of the FIM to the scientific community has been limited, but the development of atom probe microanalysis now permits identifying the individual atoms imaged in FIM. The resulting potential for studying nanometer-scale composition fluctuations has prompted abundant development work in laboratories in the United States, Japan, and Europe. Improvements in ultra-high vacuum technology, mass spectrometry, specimen preparation techniques, and low-temperature imaging procedures have made it possible to study iron, nickel, cobalt, and even aluminum-based alloys with conspicuous success. Perhaps most significant, the introduction of a laser pulse technique to remove ions from the specimen surface has made it possible to study a range of electronic materials, including silicon, gallium arsenide, and gallium phosphide, and also ternary and quaternary materials. Practical applications of the laser techniques were increasingly evident at the meeting.

A decision was made at the meeting to establish an International Field Emission Society to promote the development of this branch research. This quickly growing area bears watching.

The conference proceedings will be published in December 1985 as a special issue of *Journal de Physique*.

https://doi.org/10.1557/S0883769400044213 Published online by Cambridge University Press