Louis rather than some upwind source. On 11 August, the plume again stretched out toward the northeast and was mapped in detail out to 145 km and tracked out to 240 km. Winds on this date were lighter than on 18 July but the plume was as well defined, and concentrations and flow rates were similar.

W. H. WHITE, J. A. ANDERSON
D. L. BLUMENTHAL
Meteorology Research, Inc.,
Altadena, California 91001
R. B. HUSAR, N. V. GILLANI
J. D. HUSAR
Washington University,
St. Louis, Missouri 63130
W. E. WILSON, JR.
U.S. Environmental Protection Agency,
Research Triangle Park,
North Carolina 27711

References and Notes

1. P. L. Haagenson and A. L. Morris, *J. Appl. Meteorol.* **13**, 901 (1974).
2. J. F. Stampfer, Jr., and J. A. Anderson, *Atmos. Environ.* **9**, 301 (1975).
3. R. J. Breeding, P. L. Haagenson, J. A. Anderson, J. P. Lodge, Jr., J. F. Stampfer, Jr., *J. Appl. Meteorol.* **14**, 204 (1975); R. J. Breeding, H. B. Klonis, J. P. Lodge, Jr., J. B. Pate, D. C. Sheesley, T. R. Englert, D. R. Sears, *Atmos. Environ.* **10**, 181 (1976).
4. R. B. Husar, J. D. Husar, N. V. Gillani, S. B. Fuller, W. H. White, W. M. Vaughan, W. E. Wilson, Jr., paper presented as part of the proceedings of the Division of Environmental Chemistry, 171st national meeting of the American Chemical Society, New York, April 1976.
5. K. T. Whitby, B. K. Cantrell, R. B. Husar, N. V. Gillani, J. A. Anderson, D. L. Blumenthal, W. E. Wilson, Jr., *ibid*; W. E. Wilson, Jr., R. J. Charlson, R. B. Husar, K. T. Whitby, D. L. Blumenthal, paper 76-30-06 presented as part of the proceedings of the 69th annual meeting of the Air Pollution Control Association, Portland, Ore., June 1976.
6. The quantity b_{scat} gives the rate (fraction per distance) at which a beam of light is scattered in all directions and is the main determinant of visual range in the atmosphere. In polluted urban air, b_{scat} is roughly proportional to the mass concentration of aerosol particles in the diameter range from 0.2 to 2.0 μm, those inhaled most deeply into the lungs [see R. J. Charlson, N. C. Ahlquist, H. Selvidge, P. B. MacCready, Jr., *J. Air Pollut. Control Assoc.* **19**, 937 (1969)].
7. The sampling aircraft was instrumented to measure O_3, NO, NO_2, and SO_2 concentrations, aerosol size distribution, b_{scat}, electrical charge acceptance and condensation nuclei count, temperature, relative humidity, dew point, and turbulent dissipation, as described by W. H. White, J. A. Anderson, W. R. Knuth, D. L. Blumenthal, J. C. Hsiung, and R. B. Husar [Final Report No. MR176-FR-1414, Meteorology Research, Inc., Altadena, Calif., 1976]. Submicrometer aerosol samples were collected for sulfate analysis as described by J. D. Husar, R. B. Husar, and P. K. Stubits [*Anal. Chem.* **47**, 2062 (1975)].
8. Data supplied by the U.S. Environmental Protection Agency and the Illinois Environmental Protection Agency.
9. H. M. Walker, paper presented as part of the proceedings of the Conference on Ozone/Oxidants, Air Pollution Control Association, Dallas, Tex., March 1976.
10. W. E. Wilson, Jr., D. F. Miller, A. Levy, R. K. Stone, *J. Air Pollut. Control Assoc.* **23**, 949 (1973).
11. A. P. Waggoner, A. J. Vanderpol, R. J. Charlson, S. Larsen, L. Granat, C. Trägårdh, *Nature (London)* **261**, 120 (1976); W. H. White, P. T. Roberts, S. K. Friedlander, in preparation.
12. This research was supported by the U.S. Environmental Protection Agency, Environmental Sciences Research Laboratory, Aerosol Research Branch. This report is MISTT Report 4.

4 February 1976; revised 28 June 1976

Electrochemical Growth of Highly Conducting Inorganic Complexes

Abstract. *The formation of single crystals of highly conducting inorganic complexes, for example,* $K_2Pt(CN)_4X_{0.3} \cdot 3H_2O$ (X = Cl, Br), $K_{1.75}Pt(CN)_4 \cdot 1.5H_2O$, *or* $K_{1.64}Pt(O_2C_2O_2)_2 \cdot 2H_2O$, *has been effected via electrochemical growth from concentrated aqueous solutions of potassium tetracyanoplatinate(II) and potassium bis(oxalato)platinate(II).*

In recent years there has been a great interest (*1*) in the chemical and physical properties of highly conducting molecular complexes. This interest has resulted from observation of a number of unusual anisotropic physical phenomena (for example, high conductivity, metallic state, metal-insulator transition, charge density wave, superconductivity) and chemical properties (for example, novel structures containing infinite chains with short interplanar spacings, mixed valency, and homogeneous nonstoichiometric compositions) directly associated with numerous one-dimensional systems (*2, 3*). In order to measure the intrinsic physical properties of such complexes, it is necessary to have high-quality single crystals suitable for various measurements. Typically, various highly conducting materials containing a transition metal form fibrous needles that are difficult to analyze by single-crystal techniques. Furthermore, because of the pseudo one-dimensionality of such systems, impurities or defects, or both, will strongly influence various physical properties and, in particular, the electrical transport (for example, conductivity) properties of such materials. Thus, because large single crystals of $K_2Pt(CN)_4Br_{0.3} \cdot 3H_2O$ (KCP) have been available, this material has been the most extensively studied highly conducting inorganic one-dimensional system to date.

Single crystals of highly conducting inorganic complexes have traditionally been grown by crystallization from solution (*2*). However, the electrical properties of such materials can be utilized to grow single crystals via electrolysis at an anode. Upon nucleation at the anode, growth proceeds primarily along the conducting axis of the crystal such that the introduction of an impurity or defect will impede the current flow and crystal formation. However, as a result of microscopic reversibility, defects may be eliminated and growth may proceed, thereby making possible the fabrication of a high-quality crystal. Such electrochemical synthesis has been effected with the use of aqueous ~0.2M solutions of $K_2Pt(CN)_4$ and ~ 0.02M $K_2Pt(O_2C_2O_2)_2$ in an electrolysis cell comprised of a platinum anode and cathode. Application of a 1.5-volt potential (*4*) causes nucleation and growth of needle crystals of $K_{1.75}Pt(CN)_4 \cdot 1.5H_2O$ and gas evolution at the cathode. This process is consistent with the following anodic and cathodic half cell reactions:

$$1.5H_2O + 1.75K^+ + Pt(CN)_4^{2-} \xrightarrow{H_2O} K_{1.75}Pt(CN)_4 \cdot 1.5H_2O + 0.25e^-$$

$$2H_2O + 2e^- \rightarrow H_2 + 2OH^-$$

In the presence of halide ions, that is, Cl^- or Br^-, KCP nucleates by an alternate anodic reaction:

$$0.3X^- + 2K^+ + Pt(CN)_4^{2-} + 3H_2O \xrightarrow[X\,=\,Cl,\,Br]{H_2O} KPt(CN)_4X_{0.3} \cdot 3H_2O + 0.3e^-$$

In a similar manner, other highly conducting inorganic complexes can be grown. For example, anodic oxidation of potassium bis(oxalato)platinate(II) results in the formation of the cation-deficient species $K_{1.64}Pt(O_2C_2O_2)_2 \cdot 2H_2O$ presumably via the anode reaction:

$$1.64K^+ + Pt(O_2C_2O_2)_2^{2-} \xrightarrow{H_2O} 0.36e^- + K_{1.64}Pt(O_2C_2O_2)_2 \cdot 2H_2O$$

A typical electrochemical growth is shown on the front cover.

Thus, electrochemical growth provides an attractive alternate technique for the synthesis of highly conducting pseudo one-dimensional inorganic complexes. Furthermore, evaluation of the electrochemical parameters makes it possible for us to probe for the first time the stoichiometric, kinetic, and thermodynamic features of these systems.

JOEL S. MILLER
Webster Research Center,
Xerox Corporation,
Rochester, New York 14644

References

1. W. D. Metz, *Science* **190**, 450 (1975).
2. For a review of highly conducting inorganic complexes, see, for example, J. S. Miller and A. J. Epstein, *Prog. Inorg. Chem.* **20**, 1 (1976), and references therein.
3. M. J. Rice, *Phys. Bull.* **26**, 493 (1975).
4. The $Pt^0/Pt(CN)_4^{2-}$ oxidation potential is + 0.59 volt (versus the standard calomel electrode) [H. Terry, *J. Chem. Soc.* (1928), p. 202].

22 January 1976