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19 ABSTRACT (Continue on reverse if necessary and identify by block number) A large family of novel nitride materials has been discovered and examined. Unusual structural, electrical and magnetic properties were found. Work continues in this field to better understand the scope of nitride chemistry in solids and the chemical and physical properties of these unique materials.			
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FINAL TECHNICAL REPORT

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Synthesis of Novel Conducting Solids

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May 30, 1991

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FINAL REPORT

Objectives of the Research

The synthesis of new oxides, sulfides and nitrides was undertaken with the objective of discovering novel conducting properties. One goal is to discover new classes of compounds that could be high temperature superconductors. Such discovery is hoped to lead to materials with better mechanical and electrical properties than the copper oxides and possibly to provide new perspectives on the mechanism of high temperature superconductivity. A second goal is to investigate little studied classes of materials for new chemical or physical behavior. While oxides as a class have been extensively studied, compounds such as ternary nitrides are almost completely unexplored. Since there are technologically important binary nitrides, such as AlN , Si_3N_4 and NbN , it is likely that studies of ternary nitrides will produce exciting advances. A final objective is to train undergraduate and graduate students to be creative in the production and characterization of both known and novel solid state materials. Such solid state chemistry has been a neglected area of science in the US, but an area critical to many technologies.

Research Findings to Date

We have discovered a large new family of compounds: the ternary nitrides. These compounds contain an electropositive metal, such as an alkali, alkaline earth or rare earth metal, and a transition metal or post-transition metal as well as nitrogen. These include: CaNiN (Technical Reports listed below, #5), Ca_2ZnN_2 (#6), Ca_3CrN_3 (#7), Ca_3MN with $\text{M} = \text{P}, \text{As}, \text{Sb}, \text{Bi}, \text{Ge}, \text{Sn}, \text{and Pb}$ (#8,9), Ta_3N_5 (#10). The synthesis, structure and chemical and physical properties of these materials reveal significant differences in behavior from other solid state compounds. There are about a hundred new nitrides that we have prepared and observed by powder x-ray diffraction. Unravelling the structure and properties of these materials will be the subject of future research.

As part of our studies we have also investigated a few unusual oxide materials that were made first by us. These include NdNiO_2 (#1), $\text{Ba}_2\text{Nb}_2\text{O}_7$, and $\text{Sr}_2\text{Nb}_2\text{O}_7$ (#12), and studies of strong oxidants for deintercalation of oxides and other solids (#2). At the same time we developed some instrumentation necessary to measure the density of small quantities of powdered solids to help in the structure determination of our new materials (#3). Finally, a review of the status of solid state chemistry and of our research was written by the invitation of Science (#4).

ONR Technical Reports

(Note: publication citation in journals is also given)

1. "Synthesis and Properties of NdNiO₃, Prepared by Low Temperature Methods", J. K. Vassiliou, M. Hornbostel, R. P. Ziebarth and F. J. DiSalvo, J. Solid State Chemistry **81**, 208 (1989)
2. "Powerful Oxidation Agents for the Oxidative Deintercalation of Lithium from Transition Metal Oxides", A. R. Wizansky, P. E. Rauch and F. J. DiSalvo, J. Solid State Chemistry **81**, 203 (1989)
3. "A Small, Inexpensive Apparatus for the Determination of the Density of Powdered Materials" M. Y. Chern, R. D. Mariani, D. A. Vennos and F. J. DiSalvo, Rev. of Scientific Instruments, **61**, 1733 (1990)
4. "Solid State Chemistry: A Rediscovered Chemical Frontier" F. J. DiSalvo, Science **247**, 649 (1990)
5. "Synthesis, Structure, Electrical and Magnetic Properties of CaNiN" M. Y. Chern and F. J. DiSalvo, J. Solid State Chemistry **88**, 459 (1990)
6. "Ca₂ZnN₂: A New Ternary Nitride" M. Y. Chern and F. J. DiSalvo, J. Solid State Chemistry, **88**, 528 (1990)
7. "Synthesis, Structure and Magnetic Properties of a Novel Nitride: Ca₃CrN₃" D. A. Vennos, M. E. Badding and F. J. DiSalvo Inorganic Chemistry, **29**, 4059 (1990)
8. "Synthesis, Structure and Properties of Anti-Perovskite Nitrides Ca₃MN, M = P, As, Sb, Bi, Ge, Sn, and Pb" M. Y. Chern, D. A. Vennos and F. J. DiSalvo. J. Solid State Chemistry (1991)
9. "The Structural Distortion of the Anti-Perovskite Nitride AsNCa₃" M. Y. Chern, F. J. DiSalvo, J. B. Parise and J. A. Goldstone, J. Solid State Chemistry (1991)
10. "The Structure of Ta₃N₅ at 16K by Time-of-Flight Neutron Diffraction" N. Brese, M. O'Keefe, P. E. Rauch and F. J. DiSalvo, Acta Cryst. **C47**, (1991)
11. "Synthesis Structure and Properties of a New Intermetallic Compound, Ca₇Ni₄Sn₁₃" D. A. Vennos, M. E. Badding and F. J. DiSalvo, J. less Common Metals **171**, (1991)
12. "Synthesis and Properties of Some New Reduced Niobate Compounds" C. E. Michelson, P. E. Rauch and F. J. DiSalvo, Materials Research Bulletin, **25**, 971 (1990)

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