**MACH I: Pioneer in Nano-structure, Advanced Materials and Aerospace**

MACH I, Inc., is a high technology performance chemical company that provides innovative specialty chemical products and research services to the nano-structure, advanced materials and aerospace industries. MACH I was formed in 1985 by Bernard M. Kosowski, who pioneered the development of hydroxy terminated polymer (HTPB) at ARCO Chemical Company, along with other senior retired scientists from ARCO Chemical Company. A key element of MACH I's growth strategy is to develop new products and markets by leveraging or extending its existing products as well as core technical competencies. The U.S. Government's Small Business Innovation Research Program allows MACH I to do so.

The SBIR and BAA research grant programs have been key to the technical innovation and new product commercialization of MACH I. Through Federally-funded R & D, MACH I has been able to maintain an experienced and productive research staff whose budget typically accounts for 15-20% of MACH I's revenues. This level of funding has enabled MACH I to develop new products and technologies far beyond what would be possible based upon sales revenues alone.

Since its formation, MACH I has been awarded three BAA contracts, eleven Phase I SBIR contracts and five Phase II SBIR contracts. Early SBIR awards in 1988 and 1989 comprised the cornerstone of MACH I's research organization. The following summarizes some recent SBIR programs.

Under SBIR sponsorship, MACH I has extended its in-house catalysis core competencies and used the experience of Dr. John Leonard and Dr. Andy Jones to develop a novel iron phosphotungstate catalyst for DMAZ (2-di-methyl amino ethyl azide) in gas generator or mono propellant applications. DMAZ, produced by 3M, is a potential green fuel replacement for hydrazine. The catalyst that MACH I developed is more active, more stable (less coke formation), and significantly lower cost than existing catalysts. As an additional operational benefit, once deactivated, the MACH I catalyst can easily be regenerated by air exposure.

With SBIR support and Dr. Leonard as principal investigator, MACH I has expanded in-house technology for coating a high melting refractory metal with a low melting soft metal and applied its product, aluminum-coated hafnium and zirconium, for energetic applications. Both hafnium and zirconium have extreme electrostatic discharge sensitivities (ESD) that create significant safety issues and have limited their use in energetic applications. Aluminum coating improves ESD sensitivity to aluminum-like levels, a substantial improvement. MACH I is currently working with Aerojet Inc. to develop high density impulse solid propellants based on aluminum-coated zirconium.

Using similar technology, MACH I is developing a magnesium-coated boron for commercial applications. Boron, due to its high heat of oxidation and low atomic weight, is one of the highest energy density materials known. Unfortunately, it is very difficult to ignite due to its inherent reactivity and oxide surface coating. Magnesium, by comparison, is relatively easy to ignite, and by coating a boron particle with magnesium, it substantially increases the ignition characteristics. In this application, the burning magnesium heats the boron particle, as well as keeps the surface relatively clear of boron oxide.

MACH I typically utilizes senior retired scientists as principal investigators for this research. Albert Condo was the principal investigator of research to develop a synthesis method for narrow molecular weight and low viscosity carboxy-terminated polybutadiene (CTPB) and high-energy density fuel gel for propulsion. Mr. Condo also investigated the microencapsulation of liquid hydrocarbon fuels and liquid catalysts to a powder form, and developed calibrated microencapsulated sensors (CAMES®) for measuring sheer stress during mixing of propellants and munitions. He is currently doing research for a microencapsulated marine anti foulant for paint applications, and he is planning a program to generate $H_2$ gas for fuel cell applications to provide distributive energy for military deployments.

Other internal research programs at MACH I include Chuck Criner's research on Boron production and coating research which has led to the manufacture of magnesium coated boron powders; Dr. Gary Statton and John Consaga's work on cyclodextrin polymer nitrate, and a project on surfactants for plastic bonded explosives by Robert Taylor.

MACH I is also proud of its groundbreaking research conducted on superfine Iron Oxide, conducted by Dr. Tom Rudy. Dr. Rudy's work has resulted in a key MACH I commercial product called NANOCAT® Superfine Iron Oxide, a 3 nanometer particle size ferric oxide, used as a solid rocket propellant burning rate catalyst. NANOCAT® is produced via gas phase oxidation of a volatile iron compound, and MACH I has recently leveraged this gas phase technology to develop a catalytically active nano titania.

Through its innovative SBIR research, MACH I has successfully contributed to the driving goal of the government SBIR/STTR program, to "harness the innovative talents of the nation's small technology companies for U. S. military and economic strength." For more information on MACH I and the chemical products outlined in this article, please access the MACH I website at http://www.machichemicals.com.