CENTER FOR RESOURCE RECOVERY AND RECYCLING

Graduate Seminar Lecture Series

The Magnesium Ecosystem for Next Generation Automobile Structure

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Washburn Shops 229, noon

Adam C. Powell IV

MOxST

Adam Powell is CTO and co-founder of Metal Oxygen Separation Technologies Inc. His technical background is in materials science with a focus on process technology, including applications in electrochemistry, metal processing, polymer membranes, mechanical behavior of materials, fluid mechanics, heat transfer, physical vapor deposition, computer modeling, and high-performance computing. He holds dual SB degrees in economics and materials science and engineering and a PhD in materials engineering from MIT. His engineering work in industry, government, and academia has led to breakthroughs from mathematical modeling of phase transformations with fluid-structure interactions to titanium alloy composition control in an electron beam melting pilot plant. His more than 50 technical publications, half of which are in refereed journals, cover the topics above as well as tribology, engineering pedagogy, materials informatics, and collaborative development of public knowledge resources. He is the author of nine open source computer programs for R&D and education, and is a Debian GNU/Linux Maintainer overseeing development a suite of high-performance scientific software packages.

Magnesium is the lowest density engineering metal, with the highest stiffness-to-weight ratio and outstanding strength-to-weight. Because it exhibits half the solidification shrinkage of aluminum, one can die cast complex parts more easily. It also machines much faster than steel or aluminum, has better stiffness and thermal stability and conductivity than plastics, and better acoustic damping and dent resistance than steel.

For all of these reasons, the U.S. Automotive Materials Project (USAMP) report Magnesium Vision 2020 written in 2006 projected expanding the use of magnesium alloys from 10-12 lbs/vehicle to 350, substituting for 630 lbs of steel and aluminum. This reduces weight by 290 lbs/vehicle, not including secondary powertrain weight reduction for the lighter vehicle. This material substitution alone will improve efficiency by 1.5-2 miles per gallon and extend battery range for PHEV and electric vehicles. And some auto makers would like to fabricate entire vehicle bodies and frames from magnesium alloys, realizing much larger gains.

Unfortunately, in the few years since Mg 2020, magnesium prices have more than doubled. The processes that make the metal, Pidgeon silicothermic reduction and chloride electrolysis, are also very energy-intensive and environmentally harmful. Metal Oxygen Separation Technologies (MOxST, pronounced “most”) is trying to replace these processes for extracting magnesium from ores with clean and low-cost oxide electrolysis, which creates pure oxygen gas as a by-product. With renewable electricity and Mg(OH)2 feedstock, this leads to zero-emission primary production of magnesium. MOxST is also developing a new recycling process to produce pure magnesium from the worst grades of post-consumer mixed alloy and heavily-oxidized scrap.

These developments are crucial to realizing the full potential of magnesium as an automotive structural material. But they are not sufficient: they will also require implementation of new designs, alloys, and processes on an enormous scale, as well as changes to automotive material flows, particularly on the recycling end. This talk will describe MOxST's activities in magnesium extraction and recycling, and outline how we fit into the new ecosystem for automotive magnesium.