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Researchers Focus on Dairy's Carbon Footprint

One of the largest contributors to liquid milk's carbon footprint is enteric methane – gas emitted by the animal, research has found.

Researchers at the University of Arkansas are attempting to help the U.S. dairy industry decrease its carbon footprint as concentrations of carbon dioxide in the Earth's atmosphere reach record levels.

In 2007, Americans consumed approximately 17.4 million metric tons of fluid milk – milk consumed as a drink or with cereal, rather than milk used in dairy products such as cheese, yogurt and ice cream. The dairy industry has set a goal of 25 percent reduction in greenhouse gas emissions by 2020.

The U of A researchers' "cradle-to-grave" life-cycle analysis of milk will provide guidance for producers, processors and others in the dairy supply chain and will help these stakeholders reduce their environmental impact while maintaining long-term viability.

"Based in part on growing consumer awareness of sustainability issues in our food supply chain, the U.S. dairy industry is working to further improve the environmental performance of its production processes and supply chain in a way that is also economically sustainable," said Greg Thoma, professor of chemical engineering. "Our analysis provides a documented baseline for their improvement efforts. It is a source for understanding the factors that influence environmental impact."

The researchers – Rick Ulrich, professor of chemical engineering; Darin Nutter, professor of mechanical engineering; Jennie Popp, professor of agricultural economics and agribusiness; and Marty Matlock, professor of biological and agricultural engineering, in addition to Thoma – partnered with researchers at Michigan Technological University.

Learn More

Discovery Furthers Knowledge of Superconductivity

Jak Chakhalian, University of Arkansas

Physicists at the University of Arkansas have collaborated with scientists in the United States and Asia to discover that a crucial ingredient of high-temperature superconductivity could be found in an entirely different class of materials.

"There have been more than 60,000 papers published on high-temperature superconductive material since its discovery in 1986," said Jak Chakhalian, professor of physics at the University of Arkansas. "Unfortunately, as of today we have zero theoretical understanding of the mechanism behind this enigmatic phenomenon. In my mind, the high-temperature superconductivity is the most important unsolved mystery of condensed matter physics."

Superconductors have the ability to transport large electrical currents and produce high magnetic fields, which means they hold great potential for electronic devices and power transmission.

Derek Meyers, a doctoral student in physics at the U of A, found that the way electrons form in superconductive material — known as the Zhang-Rice singlet state — was present in a chemical compound that is very different from conventional superconductors.

The recent finding is important to further understand superconductivity, Chakhalian said.

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GRANT AWARD WINNERS

The following is a sampling of faculty awards in May, with the principal investigator, the award amount and the sponsor. An asterisk (*) indicates the continuation of a previous award.

— Janet Penner-Williams, $375,811, U.S. Department of Education
— Jesse J. Casana, $275,000, National

Art historian Leo Mazow has received the 2013 Charles C. Eldredge Prize for Distinguished Scholarship in American Art for his book Thomas Hart Benton and the American Sound.

Leo Mazow, University of Arkansas

The prize is awarded each year by the Smithsonian American Art Museum "to honor those authors who deepen or focus debates in the field, or who broaden the discipline by reaching beyond traditional boundaries." The honor includes a $3,000 prize.

"The Eldredge Prize is the most prestigious award in American art history scholarship and one of several awards Leo has won since joining our faculty in 2010," said Jeannie Hulen, chair of the art department at the U of A. "It is exciting to have such an outstanding scholar of American art as a colleague and researcher in our department."

Mazow will present the annual Eldredge Prize lecture at the Smithsonian American Art Museum in Washington, D.C., on Sept. 26.

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Research Improves Dry Lubricant

Nearly everyone is familiar with the polytetra-fluoroethylene (PTFE), otherwise known as Teflon, the brand name used by the chemical company DuPont. Famous for being "non-sticky" and water repellent, PTFE is a dry lubricant used on machine components everywhere, from

Endowment for the Humanities
— Miaoqing Huang, $187,540, Arkansas Space Grant Consortium
— Chase E. Rainwater, $147,575, National Science Foundation
— Janet Penner-Williams, $134,000, Arkansas Department of Education

Min Zou, University of Arkansas

kitchen tools and engine cylinders to space and biomedical applications.

Recently, engineering researchers at the University of Arkansas found a way to make the polymer even less adhesive. They treated thin films of PTFD with silica nanoparticles and found that the lubricating material significantly reduced wear of the polymer while maintaining a low level of friction. The researchers' work will enable machinery to last longer and operate more efficiently.

"Polytetrafluoroethylene is a big, scary word," said. Min Zou, an associate professor of mechanical engineering. "What we're talking about here is a material layer or coating – a film – that essentially does not stick and is hydrophobic, meaning it repels water."

Learn More

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University of Arkansas Arkansas Newswire

Researchers Focus on Dairy's Carbon Footprint

Life-cycle analysis identifies opportunities for emissions reduction

Friday, May 31, 2013

One of the largest contributors to liquid milk’s carbon footprint is enteric methane – gas emitted by the animal, research has found.

FAYETTEVILLE, Ark. – Researchers at the University of Arkansas are attempting to help the U.S. dairy industry decrease its carbon footprint as concentrations of carbon dioxide in the Earth’s atmosphere reach record levels.

In 2007, Americans consumed approximately 17.4 million metric tons of fluid milk – milk consumed as a drink or with cereal, rather than milk used in dairy products such as cheese, yogurt and ice cream. The dairy industry has set a goal of 25 percent reduction in greenhouse gas emissions by 2020.

The U of A researchers’ “cradle-to-grave” life-cycle analysis of milk will provide guidance for producers, processors and others in the dairy supply chain and will help these stakeholders reduce their environmental impact while maintaining long-term viability.

“Based in part on growing consumer awareness of sustainability issues in our food supply chain, the U.S. dairy industry is working to further improve the environmental performance of its production processes and supply chain in a way that is also economically sustainable,” said Greg Thoma, professor of chemical engineering. “Our analysis provides a documented baseline for their improvement efforts. It is a source for understanding the factors that influence environmental impact."

Thoma and an interdisciplinary team of U of A researchers looked at all facets and stages of milk production, from the fertilizer used to grow the animal's feed to waste disposal of packaging after consumer use. Specifically, their life-cycle analysis focused on seven areas:

- farm production and processes
- farm-to-processor transportation
- processor operations, packaging and distribution
- retail operations
- consumer transportation and storage
- post-consumer waste management
- overall supply-chain loss and waste

The researchers found that for every kilogram of milk consumed in the United States per year, 2.05 kilograms of greenhouse gases, on average, are emitted over the entire supply chain to produce, process and distribute that milk. This is equivalent to approximately 17.4 pounds per gallon. The greenhouse gases were measured as carbon dioxide equivalents and included methane, refrigerants and other gases that trap radiation. The largest contributors were feed production, enteric methane – gas emitted by the animal itself – and manure management.

The researchers identified many areas where the industry can reduce impact within feed and milk production, processing and distribution, retail and the supply chain. They focused on farms, where processes for feed production, handling of enteric methane and manure management varied greatly and therefore represent the greatest opportunities for achieving significant reductions.

The researchers suggested widespread nutrient management strategies that link inorganic fertilizer use with the application of manure for crop production. They recommended dry lot and solid storage systems as preferred management strategies, rather than anaerobic lagoons and deep bedding. Methane digesters, which biologically convert manure to methane and capture it as an energy source, should be a high priority for larger farm operations, Thoma said.

"Methane digesters have great potential as a way to capture and utilize methane, which is natural gas, that is otherwise lost to the atmosphere," he said.

At the processor and distribution level, greater emphasis on truck fleet-fuel usage and consumption of electricity will reduce emissions, the researchers said.

Implementing standard energy-efficiency practices focused on refrigeration and compressed-air systems, motors and lighting will also lead to reduction. Likewise, processor plant fuel reductions can be achieved through improved steam systems and continued energy-efficiency improvements in other operating practices.

With packaging, emissions reductions could come from improved bottle designs resulting in less material use. Specifically, changing the bottle cap manufacturing process from injection molding to thermoforming may lower environmental impact. Similar suggestions have already been made for yogurt packaging and containers.

Finally, the researchers recommended a careful examination of trucking transport distances to realize greater optimization and efficiency of routes. They also suggested transport refrigeration systems that use fewer refrigerants.

The U of A researchers – Rick Ulrich, professor of chemical engineering; Darin Nutter, professor of mechanical engineering; Jennie Popp, professor of agricultural economics and agribusiness; and Marty Matlock, professor of biological and agricultural engineering, in addition to Thoma – partnered with researchers at Michigan Technological University. Their study was published as a special issue, "Carbon and Water Footprint of U.S. Milk, From Farm to Table," of the *International Dairy Journal* in April.

Thoma is holder of the Bates Teaching Professorship in Chemical Engineering. Ulrich is holder of the Louis Owen Professorship in Chemical Engineering.

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University of Arkansas Arkansas Newswire

Discovery by University of Arkansas Physicists Furthers Understanding of Superconductivity

Experiments show Zhang-Rice singlet state in different class of materials

Tuesday, May 28, 2013

FAYETTEVILLE, Ark. – Physicists at the University of Arkansas have collaborated with scientists in the United States and Asia to discover that a crucial ingredient of high-temperature superconductivity could be found in an entirely different class of materials.

Jak Chakhalian

"There have been more than 60,000 papers published on high-temperature superconductive material since its discovery in 1986," said Jak Chakhalian, professor of physics at the University of Arkansas. "Unfortunately, as of today we have zero theoretical understanding of the mechanism behind this enigmatic phenomenon. In my mind, the high-temperature superconductivity is the most important unsolved mystery of condensed matter physics."

Superconductivity (http://www.youtube.com/watch?v=zMGCVdnLte8) is a phenomenon that occurs in certain materials when cooled to extremely low temperatures such as negative-435 degrees Fahrenheit. High-temperature superconductivity exists at negative-396 degrees Fahrenheit. In both cases electrical resistance drops to zero and complete expulsion of magnetic fields occurs.

Superconductors have the ability to transport large electrical currents and produce high magnetic fields, which means they hold great potential for electronic devices and power transmission.

The recent finding by the University of Arkansas-led team is important to further understand superconductivity, Chakhalian said.

An article detailing the finding, "Zhang-Rice physics and anomalous copper states in A-site ordered perovskites" was published Monday, May 13, in *Scientific Reports*, an online journal published by the journal *Nature*.

Derek Meyers, a doctoral student in physics at the U of A, found that the way electrons form in superconductive material — known as the Zhang-Rice singlet state — was present in a chemical compound that is very different from conventional superconductors.

"There is now a whole different class of materials where you can search for the enigmatic superconductivity," Chakhalian said. "This is completely new because we know that the Zhang-Rice quantum state, which used to be the hallmark of this high-temperature superconductor, could be found in totally different crystal structures. Does it have a potential to become a novel superconductor? We don't know but it has all the right ingredients."

Meyers was the lead researcher. Srimanta Middey, a postdoctoral research associate at the university and Benjamin A. Gray, a doctoral student, performed the theoretical calculations and analyzed the experimental data obtained at the X-ray synchrotron at Argonne National Laboratory near Chicago.

In the mid-1980s, physicists determined that all high-temperature superconductive material must contain copper and oxygen and those elements arrange two-dimensionally.

In this material the electrons combine into a unique quantum state called the Zhang-Rice singlets, Chakhalian explained.

"I can make a closed circuit out of the superconducting material, cool it down and attach a battery that starts the flow of the electrons. The current goes around the loop. Then I detach it and leave it. Hypothetically, 1 billion years later the flow of electrons is guaranteed to be exactly the same — with no losses," he said. "But the problem is we don't know if we are even using it right. We have no microscopic understanding of what is behind it."

For this project, Chakhalian acquired complex oxides from the University of Texas in Austin, in close collaboration with chemists John Goodenough and J.G. Cheng. Chakhalian's group, led by Meyers, conducted experiments on them at the Advanced Photon Source at Argonne National Laboratory.

Meyers, from Rogers, Ark., is attending the U of A on a Doctoral Academy Fellowship, which provides him an annual stipend of $10,000 to apply to his graduate research.

Chackhalian holds the Charles and Clydene Scharlau Chair in the J. William Fulbright College of Arts and Sciences.

The research team also included theorists Swarnakamal Mukherjee and Tanusri Saha Dasgupta of the S. N. Bose National Centre for Basic Sciences in Calcutta, India; Goodenough and Cheng of the University of Texas (Cheng also with the University of Tokyo and Chinese Academy of Sciences) and John W. Freeland of the Advanced Photon Source at Argonne National Laboratory.

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University of Arkansas Arkansas Newswire

U of A Art Historian Awarded Eldredge Prize

Smithsonian American Art Museum honors Leo Mazow

Monday, May 20, 2013

Leo Mazow, associate professor, art history, University of Arkansas

FAYETTEVILLE, Ark. – University of Arkansas art historian Leo Mazow has received the 2013 Charles C. Eldredge Prize for Distinguished Scholarship in American Art for his book *Thomas Hart Benton and the American Sound*. The prize is awarded each year by the Smithsonian American Art Museum "to honor those authors who deepen or focus debates in the field, or who broaden the discipline by reaching beyond traditional boundaries." The honor includes a $3,000 prize.

"The Eldredge Prize is the most prestigious award in American art history scholarship and one of several awards Leo has won since joining our faculty in 2010," said Jeannie Hulen, chair of the art department at the University of Arkansas. "It is exciting to have such an outstanding scholar of American art as a colleague and researcher in our department."

"Leo Mazow's book offers a new model for examining artworks that combines formal, archival and social analysis with fascinating results," said Elizabeth Broun, the Margaret and Terry Stent Director of the Smithsonian American Art Museum.

"Mazow's *Thomas Hart Benton and the American Sound* reverberates with potent ideas about the relationship between the history of visual art and sound," the jurors

Thomas Hart Benton and the American Sound by Leo G. Mazow

wrote. "By contextualizing Benton's paintings within a sonic environment — a world of radio, recordings, the whistles of trains and the scream of machinery — Mazow illuminates our understanding of the artist's formal designs and rhythms and expands the manner in which we perceive his vernacular subjects. Delightfully written in language that sings and shouts along with its themes, Mazow's book offers an entirely new way of relating Benton's work to the sounds of his time."

Benton is perhaps best known for his Regionalist paintings and his murals produced for such sites as the Missouri State Capitol and the Whitney Museum of New York. "However, Benton's art reveals a deep engagement with senses other than vision, particularly that of sound. Aurality, voice, musical instruments, and the sounds of machines and recording devices are referenced throughout his work," Mazow said.

Hailing from Neosho, Mo., and widely known as the teacher of Jackson Pollock, Benton came from a long line of politicians, and Mazow's book demonstrates that the artist had similar populist goals, preserving in paint the voice — and sounds — of the folk.

Benton was a self-taught and frequently performing musician who invented a harmonica entablature notation system used in music tutorials to the present day. Mazow found he was also a collector, cataloguer, transcriber and distributor of popular music. Mazow's book, however, shows that musical imagery was part of a larger belief in the capacity of sound to register and convey meaning.

"In Benton's pictorial universe, it is through the form and subject matter of sound that stories are told, opinions are voiced, experiences are preserved, and history is recorded," Mazow writes in his book. "All that is consequential, or so the artist would have us believe, has both voiced and heard components."

The Eldredge Prize is named in honor of a former director of the Smithsonian American Art Museum. According to the museum, the prize "seeks to recognize originality and thoroughness of research, excellence of writing, clarity of method, and significance for professional or public audiences.”

Mazow will present the annual Eldredge Prize lecture at the Smithsonian American Art Museum in Washington, D.C., on Sept. 26.

Mazow is associate professor of art history in the J. William Fulbright College of Arts and Sciences at the University of Arkansas. *Thomas Hart Benton and the American Sound* was published by the Pennsylvania State University Press. His work on this publication was supported by a grant from the Wyeth Foundation for American Art, administered by the College Art Association, as well as a senior fellowship at the Smithsonian American Art Museum.

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University of Arkansas Arkansas Newswire

Research Improves Dry Lubricant Used in Machinery and Biomedical Devices

Silica nanoparticles help reduce wear and friction

Friday, May 17, 2013

FAYETTEVILLE, Ark. – Nearly everyone is familiar with the polytetrafluoroethylene (PTFE), otherwise known as Teflon, the brand name used by the chemical company DuPont. Famous for being "non-sticky" and water repellent, PTFE is a dry lubricant used on machine components everywhere, from kitchen tools and engine cylinders to space and biomedical applications.

Min Zou, University of Arkansas.

Recently, engineering researchers at the University of Arkansas found a way to make the polymer even less adhesive. They treated thin films of PTFD with silica nanoparticles and found that the lubricating material significantly reduced wear of the polymer while maintaining a low level of friction. The researchers' work will enable machinery to last longer and operate more efficiently.

"Polytetrafluoroethylene is a big, scary word," said. Min Zou, an associate professor of mechanical engineering. "What we're talking about here is a material layer or coating – a film – that essentially does not stick and is hydrophobic, meaning it repels water."

Solid lubricants such as PTFE are appealing because they perform well in high temperatures, have low maintenance costs and are clean compared to liquids. They are essential in an industrial setting, where the surfaces of various mechanical parts are constantly coming into contact with each other.

This image shows silica nanoparticles on the surface of polytetrafluoroethylene, a widely used polymer.

PTFE compares favorably to other solid lubricant materials because of its self-lubricating properties, its ability to produce low friction and its resistance to high temperatures and chemicals. It has been used as a lubrication polymer for many years, and recently scientists and engineers have attempted to improve the material by incorporating nanoparticle "fillers" that reduce wear on the material and thus extend its life. However, high concentrations of these nano-fillers have created a problem: while reducing wear, they have also increased the material's ability to create friction.

"A great obstacle in micro- and nanocomposite films has been the inability to find a filler material that provides good wear resistance as well as a low coefficient of friction," Zou said.

But that's exactly what Zou found in silica. After integrating the nanoparticle material into PTFE in two different concentrations, she and her graduate student Samuel Beckford applied the thin films to a stainless steel substrate. They subjected the films to abrasive tests to measure the degree of friction and wear resistance. For comparison, they did the same experiments on a pure PTFE film and on bare stainless steel. Andrew Wang with Ocean NanoTech, a local technology firm, helped with size characterization of the nanoparticles.

"Micrographs revealed that the composite films with higher concentration of silica had much narrower wear tracks after the samples were subjected to rubbing tests," Zou said.

The study was published in *Tribology Transactions*, a journal of the Society of Tribologists and Lubrication Engineers (STLE), and received the STLE Al Sonntag Award for the best paper published on solid lubricants.

Zou is holder of the 21st Century Professorship in Mechanical Engineering.

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