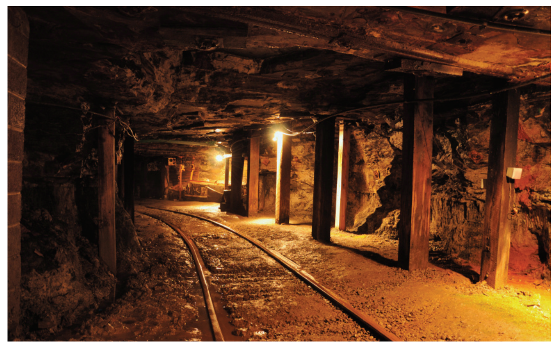
Center for Particulate and Surfactant Systems (CPaSS)

University of Florida, Brij Moudgil, Director, 352.846.1194, bmoudgil@erc.ufl.edu
Columbia University, Ponisseril Somasundaran, 212.854.2926, ps24@columbia.edu

Center website: http://iucrc.perc.ufl.edu/

Prototype Greenness Index for Mineral Resource Development

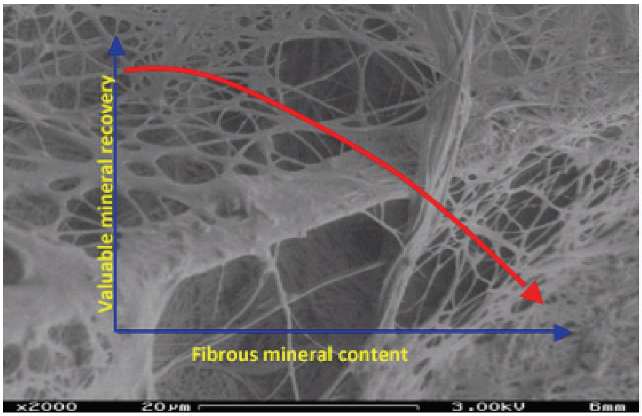


A new Greenness Index based on an integration of the Twelve Principles of Green Chemistry and ICMM's ten principles for Sustainable Mining Development is in the prototype stage. This tool will bridge the existing gap between focused efforts in the chemical and mineral processing industries. The Greenness Index will allow mining companies to evaluate the multifarious aspects of sustainability in mineral processing operations. Supported by several major mining companies, this collaborative and comprehensive effort is the first of its kind. Over the next twelve months the algorithm will be tested and refined for chemically assisted flotation operations. This will ultimately allow the economic and environmental impact of sustainable processes to be engineered.

Economic Impact: This new initiative and the progress made in the past year has already spurred great interest in the mining and the chemical industry in terms of providing a framework and tools to evaluate and account for chemicals in the mining life cycle. The work is designed to provide the necessary metrics to evaluate current industry standards. With iterative refinements to the prototype, we plan to develop a robust tool that can suggest greener alternatives to old industry standards. Nationally it promotes awareness of the use and impact of chemicals and open accountability. The integration of the Twelve Principles of Green Chemistry and ICMM's ten principles for Sustainable Mining Development philosophy into the prototype is essential to promote greener mineral processing.

For more information, contact Ponisseril Somasundaran, 212.854.2926, ps24@columbia.edu.

Sustainable Mineral Resource Recovery



Network formation by fibrous minerals leading to poor mineral recovery and process efficiency.

One of the major sustainability challenges facing the mineral industry today is the selective and efficient recovery of strategically important valuable minerals and metals from low quality complex ores. Processing of ores is characterized by poor mineral recovery and high water and energy consumption. Flotation separation, which is still the most widely used method, is severely hampered because of the presence in ores of waste minerals, notably silicates. While the adverse effects of waste minerals are well recognized, the root causes for these effects remained elusive, thereby impeding development of robust solutions to the problem.

In collaboration with Vale and Cytec Industries, CPaSS researchers have uncovered important root causes. The pioneering work has demonstrated that the shape and morphology of the waste silicates have large negative impacts on processing efficiency; in some cases far greater than that resulting from the chemistry of such silicates. Most notably, strong evidence was found for complex fibrous networks in suspensions of the ground ores. These networks dramatically increase slurry viscosity, reduce the efficiency of gas dispersion and bubble-particle attachment; all of which lead to poor separation and process efficiency.

The prevailing belief in the scientific community was that the detrimental effect of waste silicates was due to hetero-coagulation between the silicates and the valuable minerals, generally referred to as slime coating. CPaSS research has demonstrated that platy, acicular or fibrous particles interact and entangle in ore suspensions to form micro and macro networks, which result in dramatic changes in slurry rheology, gas dispersion and bubble-particle attachment. Such network formation leads to several undesirable consequences: transport of large amounts of non-value silicates to the value mineral concentrate by bubble flux, reduction in valuable mineral recovery, high water and energy consumption. Our initial discoveries were made in Ni ores.

> **Economic Impact:** This novel research will have a significant scientific and technological impact, allowing us to devise ways to enhance selective separation of valuable minerals from complex and poor quality ores while consuming less water and energy, thereby addressing the sustainability challenges facing the U.S. industry for the foreseeable future. Plant operators will benefit by implementing our recommendations and solutions, particularly in diagnosing the problem before processing, and making better decisions related to selection of reagents and conditions.

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