The Fossil Report

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Energy Technology for the Future...and for the World

Remote Sensing To Monitor Environmental Change

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Why do leaves change color in the Fall? We all know that the leaves of a deciduous tree change color in the Fall and drop to the ground.

Healthy leaves capture sunlight in Chlorophyll and transform carbon dioxide and water into hydrocarbons and oxygen. Leaves are green because Chlorophyll reflects more green than red or blue.

In the Fall, the Chlorophyll degrades, the leaf structure collapses, and the leaf structure becomes apparent.

Some of the Fall colors are always present in the plants, while others are influenced by weather. Yellow and orange carotenoids are present in the leaves all the time but are masked by the green chlorophyll.

During the warm days of Fall, the leaves can still make sugars by photosynthesis. When the night temperatures fall, the transport of the sugars from the leaves is slowed and these sugars are converted into the red anthocyanins. If the plants were under stress during the summer, they may have produced red anthocyanins.

Fall color is a familiar example that environmental stress can cause biochemical changes and color changes in plants.

An ORNL team is beginning a project with Chevron and the University of California at Davis (UCD) to develop remote (airplane or satellite) hyperspectral sensor techniques to monitor environmental change for the oil industry.

What is a hyperspectral sensor? We are all familiar with black and white and color photos. We know that there are night vision systems that detect infrared radiation. While a color camera detects three colors (red, blue, and green), a hyperspectral camera measures the intensity of hundreds of distinct bands in the visible and near infrared region from 350 to 2500 nm.

The project objective is to use hyperspectral sensing to identify plant species, map vegetation, characterize soil properties, identify contamination, classify ecological units

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ORNL and Special Metals to Develop ODS Alloy for Heat Exchanger Tubing

The ORNL Fossil Energy Materials Program is working with Special Metals Corporation to generate information for incorporation into a database to permit oxide dispersion-strengthened (ODS) alloys to be used in the design, construction, and operation of heat exchangers in the very high-temperature environments of interest in Vision 21 power plant modules.

Oxide dispersion-strengthened alloys have the potential for safe operation at temperatures significantly higher than possible with current heat-resistant alloys.

This capability is possible because high-temperature creep strength is derived from the incorporation of a dispersion of oxide particles that are thermodynamically more stable than the intermetallic or carbide strengthening phases used in conventional wrought alloys.

As a result, ODS alloys represent the maximum temperature capability of metallic alloys that can be used in tube and sheet form.

The temperature capability of these alloys is such that they allow operation at the lower end of the temperature range for

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and habitat characteristics, and differentiate causes of vegetation stress.

The oil industry is responsible for large tracts of land all over the world, used for production, refining, or marketing. Environmental assessment of large lease holdings, conducted by traditional field means, is both extremely laborious and expensive.

If this project is successful with the development of appropriate techniques for the oil industry, the benefits will be very large.

With remote sensing, the abilityexists to reduce the time required for acquisition of important environmental information from months to days.

Further, the data acquired can have a resolution of meters, as opposed to current field monitoring where sampling sites often are tens of meters apart.

Remote data can be collected on a regular basis to detect and quantify environmental change. Regular data collection has a huge impact on the ability of the oil industry to baseline and monitor environmental issues.

By understanding environmental conditions, capital and remediation projects can be targeted, saving millions of dollars. The ability to monitor conditions more closely, and in a more timely manner, will improve management and protection of the environment.

During the first phase of the project, a greenhouse experiment on several plant species will be performed at UCD to determine if stress from hydrocarbons and metals can be distinguished spectrally from each other. During the experiment, hyperspectral data sets will be collected on a regular schedule with a field spectrometer appropriate for this application (spectral range of 350 to 2500 nm, high spectral resolution, and rapid operation). ORNL will develop methods for detecting stress differences.

The presence of Chlorophyll in vegetation leads to strong absorption in the visible band (350 to 700 nm). In the infrared band from 700 to 1300 nm, the strong reflectance is due to the discontinuity between air and the leaf cell. The sudden transition from the strong absorption in the visible to the strong reflectance in the infrared is called the red-edge and can vary between 690 to 740 nm in fresh leaves. In the infrared band from 1300 to 2500 nm, the reflectance of a leaf is almost the same as the reflectance of water.

Each reading from the spectrometer produces a vector with hundreds of values. The objective of data analysis is to differentiate between the vectors for the control group and for the stressed groups. Normally, the control group would be green (high reflectance from 491 to 575 nm) and stressed could be yellow, orange, or red (575 to 700 nm). Stress could change the position of the red-edge while drought would change the reflectance in the water band (1300 to 2500 nm).

For more information of this exciting new approach to environmental monitoring, please contact ***Dave Reister.***

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which it is usually assumed that ceramic materials will be required. Hence, incorporation of ODS alloys into the design of advanced heat transfer modules would not only increase their temperature capability, but also would reduce the size of any downstream ceramic heat transfer component required if even higher temperatures were required.

A first objective of this new work is to characterize the effectiveness of modified processing routes aimed at optimizing the mechanical properties of the ODS-FeCrAl alloy, INCO® MA956, for application as tubing. Property measurements will form part of the data package required for submission of a case for obtaining **ASME Boiler and Pressure Vessel Code** qualification for this alloy.

A second goal is to evaluate the available techniques for joining ODS alloys, to provide a sound basis for fabrication options.

A third objective is to develop a basis for service lifetime prediction based on the high-temperature oxidation behavior of this alloy.

The peculiar properties of ODS alloys do not allow their strength benefits to be fully exploited when retrofitted into existing designs, which are based on the properties of current heat-resistant alloys.

The data to be generated are intended to provide designers of heat transfer modules—and of other components requiring exceptional high-temperature strength—with the basis needed to consider ODS alloys in their initial design work.

For more information on this work, please contact ***Ian Wright.***

Conference Dates Set

The Fifteenth Annual Conference on Fossil Energy Materials will be held in Knoxville, Tennessee, from April 30 to May 3, 2001. Additional details will be posted in the near future on the **Fossil Energy Program Web site**.