

The present compact windscreen is based on an entirely different principle: that infrasound at sufficiently large wavelength can penetrate any barrier of practical thickness. Thus, a windscreen having solid, non-porous walls can block connected pressure fluctuations from the wind while transmitting infrasonic acoustic waves. The transmission coefficient depends strongly upon the ratio between the acoustic impedance of the windscreen and that of air. Several materials have been found to have impedance ratios that render them suitable for use in constructing walls that have practical thicknesses and are capable of high transmission of infrasound. These materials (with their impedance ratios in parentheses) are polyurethane foam (222), space-shuttle tile material (332), balsa (323), cedar (3,151), and pine (4,713).

A small wind tunnel was built to test the acoustical properties of a variety of windscreen materials. A fan generated wind at speeds up to 21 mph (9.4 m/s) across an infrasonic microphone. Tests were conducted with and without the windscreen; the difference in the noises detected in

the presence and absence of the windscreen was used as a measure of the attenuation of wind noise by the windscreen.

The windscreen that performed best in the wind-tunnel tests was a cylinder made of polyurethane foam of a type known in the industry as “eight-pounder,” having an inside diameter of 3 in. (7.62 cm), a wall thickness of 0.5 in. (1.27 cm), and a length of 12 in. (30.48 cm). The attenuation of wind-generated noise was quantified as the ratio between the wind noises measured without and with this windscreen. The results, plotted in the upper part of Figure 1, show that this windscreen attenuated wind noise by amounts ranging from 12 to 20 dB at frequencies ranging from 0.7 to 20 Hz. The large spikes in the spectrum represent aeolian tones generated by the wind passing over the windscreen, but these lie above the infrasonic range.

For measurements of the infrasound-transmission coefficient of this windscreen, a subwoofer was placed at an end of the wind tunnel and used to generate a tone that was swept over the frequency band from 10 to 200 Hz. In this case, the

ratio between detected sounds, with and without the windscreen, was taken as a measure of the transmission through the windscreen. The results for the portion of the spectrum from 10 to 100 Hz, plotted in the lower part of Figure 1, show that this windscreen had a large transmission coefficient at frequencies below 25 Hz, even exhibiting a gain as high as 8 dB at 10 Hz, but then attenuated sound at higher frequencies. Finally, a soak test revealed that the water absorbed by the polyurethane windscreen material amounted to only 2.1 percent by weight.

Figure 2 shows a windscreen installed over a microphone mounted on a pole in the field. The windscreen has proved robust in weather conditions of all seasons and it survived Hurricane Isabel with wind gusts up to 67 mph (30 m/s).

This work was done by Allan J. Zuckerwar, Qamar A. Shams, Bradley S. Sealey, and Toby Comeaux of Langley Research Center. For further information, contact the Langley Innovative Partnerships Office at (757) 864-3521. LAR-16833-1

Broadband External-Cavity Diode Laser

This relatively simple, inexpensive device is suitable for use in survey spectroscopy.

John H. Glenn Research Center, Cleveland, Ohio

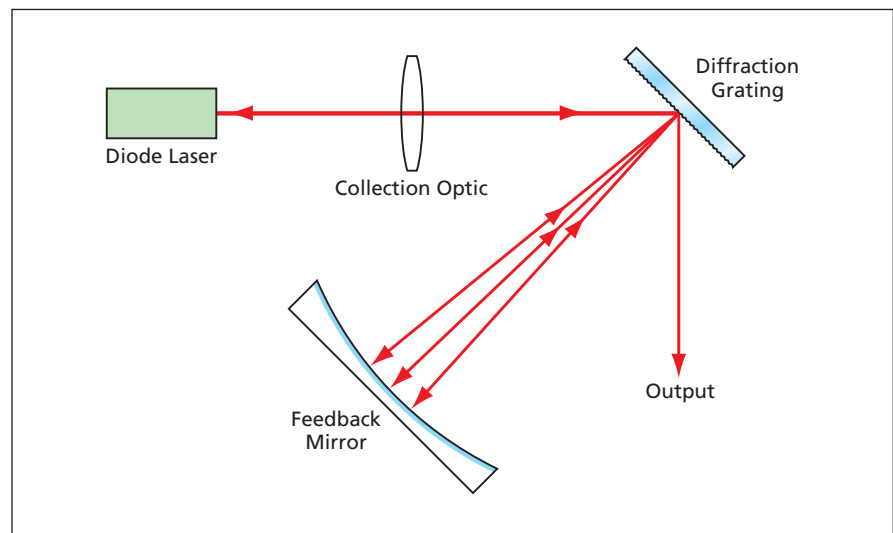
A broadband external-cavity diode laser (ECDL) has been invented for use in spectroscopic surveys preparatory to optical detection of gases. Heretofore, commercially available ECDLs have been designed, in conjunction with sophisticated tuning assemblies, for narrow-band (and, typically, single-frequency) operation, as needed for high sensitivity and high spectral resolution in some gas-detection applications. However, for preparatory spectroscopic surveys, high sensitivity and narrow-band operation are not needed; in such cases, the present broadband ECDL offers a simpler, less-expensive, more-compact alternative to a commercial narrowband ECDL.

To be precise, the output of the tunable, broadband ECDL consists of many narrow spectral peaks spaced at narrow wavelength intervals that, taken together, span a broad wavelength band. The broadband ECDL can, therefore, be likened to a light-emitting diode except that the spectrum incorporates the external-cavity mode structure. Unlike

light-emitting diodes, the ECDL offers the greater brightness, simpler fiber coupling, and superior spatial propagation properties of a laser. For example, the broadband ECDL is easily coupled into multiple-pass optical-path-length-

enhancement cells. A tunable filter — preferably, a monochromator or a spectrometer — is used to select a portion of the output spectrum.

The optical configuration of the broadband ECDL (see figure) is based



The **Feedback Mirror Is Made Curved** (in contradistinction to flat) to make it select a range of wavelengths (in contradistinction to a single wavelength).

on, but differs from, a standard configuration known in the art as that of the Littman-Metcalf design. Whereas heretofore, a flat feedback mirror would be used to select a single laser output wavelength, in the present case, a curved feedback mirror is used to select multiple wavelengths. Preferably, the feedback mirror is cylindrical or spherical and is positioned with its center of curvature at the point of diffraction (the intersection of the laser beam with the diffraction grating).

In this configuration, each wavelength component diffracted from the

grating is reflected from the mirror back to the point of diffraction. Thus, many wavelength components are simultaneously oscillating in the external cavity. The wavelength range is determined by the range of angles intercepted by the mirror; hence, the wavelength range can be adjusted by moving the mirror to a different position on the diffraction circle. The zeroth-order output of the diffraction grating is used as the laser output.

The length of the external cavity (including the mirror radius) determines the longitudinal mode spacing. It is

preferable to make this spacing smaller than the wavelength resolution of tunable filter, so that for the purpose of filtering, the ECDL spectrum can be regarded as continuous.

This work was done by Jeffrey S. Pilgrim of Southwest Sciences, Inc. for Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-17486-1.

High-Efficiency Solar Cells Using Photonic-Bandgap Materials

Energy-conversion efficiencies exceeding 50 percent may be possible.

NASA's Jet Propulsion Laboratory, Pasadena, California

Solar photovoltaic cells would be designed to exploit photonic-bandgap (PBG) materials to enhance their energy-conversion efficiencies, according to a proposal. Whereas the energy-conversion efficiencies of currently available solar cells are typically less than 30 percent, it has been estimated that the energy-conversion efficiencies of the proposed cells could be about 50 percent or possibly even greater.

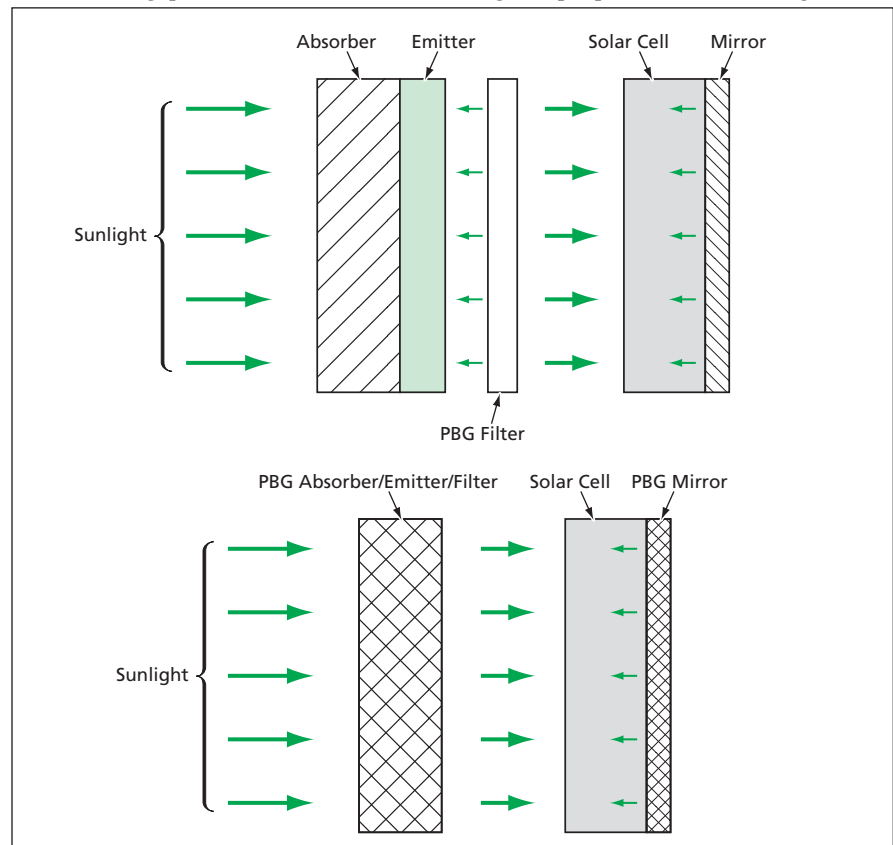
The primary source of inefficiency of a currently available solar cell is the mismatch between the narrow wavelength band associated with the semiconductor energy gap (the bandgap) and the broad wavelength band of solar radiation. This mismatch results in loss of power from both (1) long-wavelength photons, defined here as photons that do not have enough energy to excite electron-hole pairs across the bandgap, and (2) short-wavelength photons, defined here as photons that excite electron-hole pairs with energies much above the bandgap. It follows that a large increase in efficiency could be obtained if a large portion of the incident solar energy could be funneled into a narrow wavelength band corresponding to the bandgap. In the proposed approach, such funneling would be effected by use of PBG materials as intermediaries between the Sun and photovoltaic cells.

The approach involves a thermophotovoltaic principle in addition to the use of PBG materials. The basic idea is to tailor the wavelength- and direction-dependent emissivity of one or more PBG

material(s) such that as much as possible of the wavelength-mismatched portion of the incident broad-band solar power would be absorbed — the absorbed power would cause heating, and the resulting thermal radiation would be funneled into a narrow band corresponding to the bandgap of the semiconductor

material of a solar cell. Recent experiments unrelated to the development of solar cells have shown that as much as half of the thermal power could be thus re-routed into the bandgap.

The figure depicts two of many conceivable configurations for implementing the proposal. In one configuration,



PBG Materials Could Be Utilized in these and other configurations to increase the energy-conversion efficiencies of solar cells.