N93-28808 160754

INFRARED RUGATES BY MOLECULAR BEAM EPITAXY. M. Rona, Arthur D. Little, Inc., Cambridge MA 02140, USA.

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Rugates are optical structures that have a sinusoidal index of refraction (harmonic gradient-index field). As their discrete high/low index filter counterparts, they can be used as narrow rejection band filters. However, since rugates do not have abrupt interfaces, they tend to have a smaller absorption, hence deliver a higher in-band reflectivity. The absence of sharp interfaces makes rugates even more desirable for high-energy narrowband reflectors. In this application, the lack of a sharp interface at the maximum internal standing wave electric field results in higher breakdown strengths.

Our method involves fabricating rugates, with molecular beam epitaxy [1], on GaAs wafers as an Al(x)Ga(1−x)As single-crystal film in which x, the alloying ratio, changes in a periodic fashion between $0 < x < 0.5$ [2]. The single-crystal material improves the rugate performance even further by eliminating the enhanced optical absorption associated with the grain boundaries. Salient features of our single-crystal rugate fabrication program, including the process control system and methodology and some representative results, are shown [3].

References: [1] Rona M. and Sullivan P. W. (1982) *Laser Induced Damage in Optical Materials: 1982 Proceedings of the Symposium (NBS-SP-69)* (H. E. Bennett et al., eds.), pp. 234–242. [2] Rona M. (1989) *Proceedings of the Topical Meeting in High Power Laser Optical Components,* 30–31 October 1989, Unclassified Papers, Naval Weapons Center NWC-TP 7080, part 1 (J. L. Stanford, ed.), pp. 431–436. [3] Rona M., *Report to the Materials Director Wright Laboratory,* Air Force Systems Command, Wright Patterson Air Force Base, Ohio 45433-6533, Report No. WL-TR-91-4144.

N93-28809 160755

PLASMA, MAGNETIC, AND ELECTROMAGNETIC MEASUREMENTS AT NONMAGNETIC BODIES. C. T. Russell and J. G. Luhmann, Institute of Geophysics and Planetary Physics, University of California, Los Angeles CA 90024-1567, USA.

p. 1

The need to explore the magnetospheres of the Earth and the giant planets is widely recognized and is an integral part of our planetary exploration program. The equal need to explore the plasma, magnetic, and electromagnetic environments of the nonmagnetic bodies is not so widely appreciated. The previous, albeit incomplete, magnetic and electric field measurements at Venus, Mars, and comets have proven critical to our understanding of their atmospheres and ionospheres in areas ranging from planetary lightning to solar wind scavenging and accretion. In the cases of Venus and Mars, the ionospheres can provide communication paths over the horizon for low-altitude probes and landers, but we know little about their lower boundaries. The expected varying magnetic fields below these planetary ionospheres penetrates the planetary crusts and can be used to sound the electrical conductivity and hence the thermal profiles of the interiors. However, we have no knowledge of the levels of such fields, let alone their morphology. Finally, we note that the absence of an atmosphere and an ionosphere does not make an object any less interesting for the purposes of electromagnetic exploration. Even weak remanent magnetism such as that found on the Moon during the Apollo program provides insight into the present and past states of planetary interiors. We have very intriguing data from our space probes during times of both close and distant passages of asteroids that suggest they may have coherent magnetization. If true, this observation will put important constraints on how the asteroids formed and have evolved. Our planetary exploration program must exploit its full range of exploration tools if it is to characterize the bodies of the solar system thoroughly. We should especially take advantage of those techniques that are proven and require low mass, low power, and low telemetry rates to undertake.

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A COMPACT IMAGING DETECTOR OF POLARIZATION AND SPECTRAL CONTENT. D. M. Rust, A. Kumar, and K. E. Thompson, Applied Physics Laboratory, The Johns Hopkins University, Johns Hopkins Road, Laurel MD 20723, USA.

A new type of image detector will simultaneously analyze the polarization of light at all picture elements in a scene. The Integrated Dual Imaging Detector (IDID) consists of a polarizing beam splitter bonded to a charge-coupled device (CCD), with signal-analysis circuitry and analog-to-digital converters, all integrated on a silicon chip. The polarizing beam splitter can be either a Ronchi ruling, or an array of cylindrical lenslets, bonded to a birefringent wafer. The wafer, in turn, is bonded to the CCD so that light in the two orthogonal planes of polarization falls on adjacent pairs of pixels. The use of a high-index birefringent material, e.g., rutile, allows the IDID to operate at f-numbers as high as f/3.5.

Without an auxiliary processor, the IDID will output the polarization map of a scene with about 1% precision. With an auxiliary processor, it should be capable of $1{:}10^4$ polarization discrimination. The IDID is intended to simplify the design and operation of imaging polarimeters and spectroscopic imagers used, for example, in planetary, atmospheric and solar research. Innovations in the IDID include (1) two interleaved 512 × 1024-pixel imaging arrays (one for each polarization plane), (2) large dynamic range (well depth of 10^6 electrons per pixel), (3) simultaneous read-out of both images at 10 million pixels per second each, (4) on-chip analog signal processing to produce polarization maps in real time, and (5) on-chip 10-bit A/D conversion. When used with a lithium-niobate Fabry-Perot etalon or other color filter that can encode spectral information as polarization, the IDID can collect and analyze simultaneous images at two wavelengths. Precise photometric analysis of molecular or atomic concentrations in the atmosphere is one suggested application.

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DIGITAL IMAGE COMPRESSION USING ARTIFICIAL NEURAL NETWORKS. M. Serra-Ricart[1], Ll. Garrido[2,3], V. Gaitan[2], and A. Aloy[4], [1]Instituto de Astrofisica de Canarias, E-38200 La Laguna (Tenerife), Spain, [2]Departament d'Estructura i Constituens de la Materia, Universitat de Barcelona, Diagonal 647, E-08028 Barcelona, Spain, [3]Institut de Fisica d'Altes Energies, Universitat Autònoma de Barcelona, E-08193 Bellaterra (Barcelona), Spain, [4]Digital Equipment Enterprise Espana SA., Provenza, 204-208, 08036 Barcelona, Spain.

The problem of storing, transmitting, and manipulating digital images is considered. Because of the file sizes involved, large amounts of digitized image information are becoming common in modern projects. Transmitting images will always consume large amounts of bandwidth, and storing images will always require special devices. Our goal is to describe an image compression transform coder based on artificial neural networks techniques (hereafter Neural Network Compression Transform Coder or NNCTC). Like all generic image compression transform coders, the NNCTC embodies a three-step algorithm: invertible transformation to the image (transform), lossy quantization (quantize), and entropy coding (remove redundancy). Efficient algorithms have already been developed to achieve the two last steps, quantize and remove redundancy [4]. The NNCTC offers an alternative invertible transformation based on neural network analysis [3].

A comparison of the compression results obtained from digital astronomical images by the NNCTC and the method used in the compression of the digitized sky survey from the Space Telescope Science Institute based on the H-transform [3] is performed in order to assess the reliability of the NNCTC.

Artificial neural network techniques are based on the dot-product calculation, which is very simple to perform in hardware [4]. It is in this sense that the NNCTC can be useful when high compression and/or decompression rates are required (e.g., space applications, remote observing, remote database access).

References: [1] Wickerhauser M. V. (1992) *Digital Signal Processing, 2,* 204. [2] Serra-Ricart M. et al. (1993) *Astron. J.,* in press. [3] Fritze K. et al. (1977) *Astr. Nachr., 298,* 189. [4] Morgan M. et al., eds. (1990) *Artificial Neural Networks Electronic Implementations,* IEEE Computer Society, Los Alamitos.

N93-28812 160758 p-1

PROTOTYPE BACKSCATTER MÖSSBAUER SPECTROMETER FOR MESURment OF MARTIAN SURFACE MINERALOGY. T. D. Shelfer[1], R. V. Morris[1], D. G. Agresti[2], T. Nguyen[3], E. L. Wills[2], and M. H. Shen[2], [1]Code SN4, NASA Johnson Space Center, Houston TX 77058, USA, [2]Physics Department, University of Alabama at Birmingham, Birmingham AL 35294, USA, [3]Lockheed Engineering and Sciences Co., Houston TX 77058, USA.

We have designed and successfully tested a prototype of a backscatter Mössbauer spectrometer (BaMS) targeted for use on the martian surface to (1) determine oxidation states of iron and (2) identify and determine relative abundances of iron-bearing mineralogies. No sample preparation is required to perform measurements; it is only necessary to bring sample and instrument into physical contact. The prototype meets our projected specifications for a flight instrument in terms of mass (<500 g), power (<2 W), and volume (<300 cm³).

A Mössbauer spectrometer on the martian surface would provide a wide variety of information about the current state of the martian surface:

1. *Oxidation state:* Iron Mössbauer spectroscopy (FeMS) can determine the distribution of iron among its oxidation states. Is soil oxidized relative to rocks?

2. *Mineralogy:* FeMS can identify iron-bearing mineralogies (e.g., olivine, pyroxene, magnetite, hematite, ilmenite, clay, and amorphous phases) and their relative abundances. FeMS is not blind to opaque phases (e.g., ilmenite and magnetite), as are visible and near-IR spectroscopy.

3. *Magnetic properties:* FeMS can distinguish between magnetite and maghemite, which are putative mineralogies to explain the magnetic nature of martian soil.

4. *Water:* FeMS can distinguish between anhydrous phases such as hematite, olivine, pyroxene, and hydrous phases such as clay, ferrihydrite, goethite, and lepidocrocite. What are the relative proportions of hydrous and anhydrous iron-bearing mineralogies?

In summary, a BaMS instrument on MESUR would provide a very high return of scientific information about the martian surface (with no sample preparation) and would place a very low resource demand (weight, power, mass, data rate) on spacecraft and lander. Our BaMS instrument can be flight-qualified within two years and is also suitable for lander missions to the Moon, comets, and asteroids.

References: [1] Agresti D. G. et al. (1992) *Hyperfine Interactions, 72,* 285. [2] Bell J. F. III et al. (1990) *JGR, 95,* 14447. [3] Klingelhofer G. et al. (1992) *Hyperfine Interactions, 71,* 1449. [4] Morris R. V. et al. (1989) *JGR, 94,* 2760. [5] Morris R. V. and Lauer H. V. Jr. (1990) *JGR, 95,* 10257.

N93-28813 160759 p-1

SPACECRAFT COMPUTER TECHNOLOGY AT SOUTHWEST RESEARCH INSTITUTE. D. J. Shirley, Southwest Research Institute, San Antonio TX 78228-0510, USA.

Southwest Research Institute (SwRI) has developed and delivered spacecraft computers for a number of different near-Earth-orbit spacecraft including shuttle experiments and SDIO free-flyer experiments. Here we describe the evolution of the basic SwRI spacecraft computer design from those weighing in at 20 to 25 lb and using 20 to 30 W to newer models weighing less than 5 lb and using only about 5 W, yet delivering twice the processing throughput. Because of their reduced size, weight, and power, these newer designs are especially applicable to planetary instrument requirements. The basis of our design evolution has been the availability of more powerful processor chip sets and the development of higher-density packaging technology, coupled with more aggressive design strategies in incorporating high-density FPGA technology and use of high-density memory chips. In addition to reductions in size, weight, and power, the newer designs also address the necessity of survival in the harsh radiation environment of space. Spurred by participation in such programs as MSTI, LACE, RME, Delta 181, Delta Star, and RADARSAT, our designs have evolved in response to program demands to be small, low-powered units, radiation tolerant enough to be suitable for both Earth-orbit microsats and for planetary instruments. Present designs already include MIL-STD-1750 and Multi-Chip Module (MCM) technology with near-term plans to include RISC processors and higher-density MCMs. Long-term plans include development of whole-core processors on one or two MCMs.

N93-28814 160760 p-2

THE BACKGROUNDS DATA CENTER. W. A. Snyder[1], H. Gursky[1], H. M. Heckathorn[1], R. L. Lucke[1], S. L. Berg[2], E. G. Dombrowski[3], and R. A. Kessel[2], [1]Code 7604, Naval Research Laboratory, Washington DC 20375-5352, USA, [2]Computational Physics, Inc., Suite 600, 2750 Prosperity Avenue, Fairfax VA 22031, USA, [3]Sachs-Freeman Associates, 1401 McCormick Drive, Landover MD 20785, USA.

The Strategic Defense Initiative Organization (SDIO) has created data centers for midcourse, plumes, and backgrounds