MICROARRAY IMAGE SCANNING pdf

1: InnoScan Series Microarray Scanners by Arrayit

Laser scanners with appropriate laser sources for scanning (nm excitation for Cy3 and nm excitation for Cy5) were used for scanning the microarray image. Quantification of the spots was carried out using an image analysis software product, ArrayVision (Imaging Research, Inc. Ontario, Canada).

An apparatus for scanning, comprising: The apparatus of claim 1, wherein the light source comprises a quasi-monochromatic light source of moderate bandwidth. The apparatus of claim 2, wherein the quasi-monochomatic light source of moderate bandwidth is a light-emitting diode LED or a superluminescent diode SLD. The apparatus of claim 2, wherein the quasi-monochromatic light source of moderate bandwidth comprises an incandescent source and an optical filter, the light emitted from the incandescent source passing through the optical filter, the optical filter limiting the wavelengths of the light transmitted through the optical filter such as to constitute quasi-monochromatic light of moderate bandwidth. The apparatus of claim 1, wherein the light source comprises a laser emitting substantially coherent light, and further comprising an optical diffuser mechanically attached to a mechanical actuator, the light emitted from the laser passing through the diffuser, the diffuser being moved with respect to the laser by the actuator, the movement of the diffuser with respect to the laser creating fluctuations in the speckle pattern of light detected by the detector, the fluctuations being adapted to remove speckle effects from the light detected by the detector. The apparatus as in claim 5, wherein the mechanical actuator is a motor rotating the optical diffuser. The apparatus of claim 1, wherein the light source comprises a beam forming system, the beam forming system causing the light emerging from the light source to be collimated. The apparatus of claim 1, wherein the light source comprises an optical polarizer. The apparatus of claim 8, wherein the optical polarizer is controllably rotated by a motor. The apparatus of claim 1, wherein the light source comprises an optical retarder, the retarder introducing an optical phase shift between two orthogonal components of light passing through the retarder. The apparatus of claim 10, wherein the optical retarder is controllably rotated by a motor. The apparatus of claim 10, wherein the optical retarder changes retardance according to an externally introduced physical parameter. The apparatus of claim 1, wherein the optical assembly comprises an optical prism. The apparatus of claim 1, wherein the specimen array comprises a two-dimensional array formed of multiple fields comprising biomolecular substances. The apparatus of claim 1, wherein the detector comprises a two-dimensional array detector. The apparatus of claim 1, wherein the light beam is in the form of a line. The apparatus of claim 1, further comprising a translation stage operably coupled to the optical assembly. The apparatus of claim 1, further comprising an actuator operably coupled to the light source. The apparatus of claim 1, further comprising an actuator operably coupled to the detector. The apparatus of claim 1, further comprising a processor coupled to the detector, the processor processing the signal from the detector to obtain a representation of the optical phase shift occurring in the portion of the specimen array. The apparatus of claim 1, further comprising a processor coupled to the detector, the processor processing a plurality of signals related to spatially distributed polarization changes as the light beam scans the specimen array to thereby provide an image of the specimen array. The apparatus of claim 23, wherein the processor provides feedback to reduce or increase resolution over a portion of the microarray. The apparatus of claim 23, wherein the processor provides feedback to skip scanning over a portion of the microarray. The apparatus of claim 23, wherein the processor provides feedback to increase the frequency of scanning over a portion of the microarray. The apparatus of claim 27, wherein the processor provides feedback to reduce or increase resolution over a portion of the microarray. The apparatus of claim 27, wherein the processor provides feedback to skip scanning over a portion of the microarray. The apparatus of claim 27, wherein the processor provides feedback to decrease or increase the frequency of scanning over a portion of the microarray. A method of imaging, comprising: The method of claim 31, wherein the specimen array is in a micro-titer plate. The method of claim 33, further comprising: The method of claim 31, wherein the specimen array is a series of discrete specimen spots. The method of claim 35, further comprising analyzing the polarization changes to determine the binding characteristics of each discrete specimen spot. The method of claim 31, wherein a specimen array having no

molecular tagging is placed in the evanescent field. A method of scanning, comprising: The method of claim 38, wherein the subsequent scanning decreases or increases resolution over a portion of the microarray. The method of claim 38, wherein the subsequent scanning skips over a portion of the microarray. The method of claim 38, wherein the subsequent scanning decreases or increases the frequency of scanning over a portion of the microarray. Discussion of the Related Art This invention relates to imaging or scanning of a biochip also referred to as a gene chip, protein chip, microarray and others. The formation of an array of biologically or chemically active spots on the surface of a substrate for identifying constituents in test material brought into contact with the array is well known. Typically, such processes require spots of, for example, oligonucleotides, cloned DNA, antibodies, peptides, receptors, enzymes, inhibitors, etc. An apparatus and method which provide for microarray scanning at high resolution and speed is needed and desirable for imaging of the microarray. SUMMARY Scanning methods and apparatus may be used to accumulate and process data regarding change in polarization state for individual points or lines or other portion of the microarray to image the microarray at high resolution and speed. The total internal reflection at any point within the cross-section of the light beam causes a phase shift between the light component polarized in the plane of incidence and the component polarized perpendicular to the plane of incidence. The reflected light is detected by a polarization-sensitive detector such as a two dimensional array detector and the signal from this detector is then processed in a computer to provide information about substances on the surface of the specimen. Spatially distributed changes in polarization state over the microarray are indicative of the substances in the specimen in the location in the specimen array corresponding to a position in the detector. In accordance with one embodiment of the present disclosure, an apparatus for scanning is provided, comprising a light source emitting a polarized light beam, and an optical assembly having a surface adapted to allow placing thereon a specimen array, the light beam from the light source being reflected by the surface to provide an evanescent field over a portion of the specimen array such that the portion of the specimen array in the evanescent field causes a polarization change in the light beam. The apparatus further includes a detector positioned to detect the polarization change in the light beam as the light beam is scanned over the specimen array. In accordance with another embodiment of the present disclosure, an apparatus for scanning is provided including a processor to process a plurality of signals related to spatially distributed polarization changes to thereby provide feedback for subsequent scanning of the specimen array. In accordance with yet another embodiment of the present disclosure, a method of imaging is provided, comprising passing a polarized light beam into an optical structure for reflection at a surface of the optical structure to provide an evanescent field over a portion of a specimen array, the portion of the specimen array in the evanescent field causing a polarization change in the light beam. The method further includes detecting the polarization change in the light beam as the light beam scans the specimen array, and processing a plurality of signals related to spatially distributed polarization changes to thereby provide an image of the specimen array. In accordance with yet another embodiment of the present disclosure, a method of scanning is provided, including processing a plurality of signals related to spatially distributed polarization changes to thereby provide feedback for subsequent scanning of the specimen array. The apparatus and method of the present disclosure are especially adapted for imaging or scanning material in an aqueous solution. It is furthermore particularly suited for detecting attachment and detachment of analytes to a two-dimensional biomolecular array positioned on a light reflection surface as part of a molecular thin film system. In various applications a plurality of discrete specimen spots are presented in an array, where the method and apparatus will image or scan the array so as to distinguish each of the discrete specimen spots. Advantageously, fluorescence or molecular tagging is not necessary but optional for use in this invention. These and other features and advantages of the present invention will be more readily apparent from the detailed description of the embodiments set forth below taken in conjunction with the accompanying drawings. Use of the same reference symbols in different figures indicates similar or identical items. It is further noted that the drawings may not be drawn to scale. A polarized light beam of known polarization state is directed into an optical assembly, for example a total internal reflection member TIR member , configured for reflection at a light reflection surface, for example a total internal reflection surface TIR surface , and then exits the optical assembly. In the context of this document,

superposition of reflections as encountered at a layered optical structure where the layer thicknesses are smaller than the coherence length of the illuminating light is referred to as a single reflection. The chemical specimen is in place on or above the light reflection surface in the evanescent field of the reflected light beam. After reflection, the beam is passed to a polarization-sensitive two-dimensional detector such as a polarizer and a camera or other types of detectors. This provides a spatially distributed map of change of polarization state in the specimen. A variety of techniques are available to determine the change in polarization such as measuring the deviation from a null condition or by comparing the input polarization state to the output polarization state. The refractive index composition of the materials within the evanescent field determines the change in the polarization state of the beam due to the reflection at the light reflection surface. A two-dimensional variation of this composition within the light reflection surface is associated with a respective variation of the polarization state spatially distributed across the cross-section of the reflected light beam. In one application, the chemical specimen forms a two-dimensional array of molecules referred to herein as receptors and generally referred to as capture agents or affinity agents with specific affinities towards respective other molecules referred to herein as ligands. In this application, the invention is utilized to indicate the presence or absence or rate of binding between ligands and receptors on the array. Such arrays commonly consist of a plurality of discrete specimen spots. The present method and apparatus images the array so as to distinguish each of the discrete specimen spots represented by the local change in polarization state in the cross-section of the reflected beam. It is noted that thickness and refractive index measurements are functions of the electronics of the detector and that spatial resolution is a function of the optics associated with the optical assembly. The invention is particularly useful in applications where the specimen is in an aqueous solution. In a particular application, the present invention is used to determine the presence of biological agents in a solution such as in immunosensor applications by measuring their attachment to antibodies on the TIR surface in the evanescent field. In another application, the present invention is used to determine the presence and structure of nucleic acid sequences in a solution by measuring their attachment to other nucleic acid sequences on the light reflection surface in the evanescent field. Described in more detail below are different embodiments of the invention. As shown in FIG. Data from detector assembly 16 is sent by an electrical signal along a connector 24 to processor 18 such as a specially programmed computer and user access system including an image display. Data can be presented as an image, a data table, a graph, or in other forms. The polarized light source assembly 12 passes polarized light of known polarization state 20, which may be varied or varying to optical assembly 14 where a light beam reflection occurs. Reflected light 22, having a changed polarization state, passes to detector assembly 16, where it is recorded spatially over the cross-section of the beam. The recorded data is sent to processor 18 where the change of polarization state is determined to provide a spatially resolved map of changes in polarization state. Where the specimens are presented as an array of discrete spots, each spot will be imaged for its change in polarization state within the spot area. The polarized light source assembly 12 has a light source 26, a beam forming member 28 if the nature of the light source is such as to make beam forming useful or necessary , a polarizer 30, and an optical retarder The optical assembly 14 has an optical element 34 which has an optical surface Also shown is a control layer 38 over optical surface 36, and between them an index matching substance A specimen 42 is positioned on light reflection surface 39 of control layer 38 in one example. In one embodiment of the invention, optical element 34 is a prism configured along with control layer 38 in relationship to the incoming light beam 20 and the exiting light beam 22 such that the beam reflects only a single time at light reflection surface 39 and then exits the prism. If the specimen is placed directly on the optical surface 36, then the optical surface 36 would be the light reflection surface. But this is not the usual application, since the specimen such as a biochip is usually prepared more conveniently on a specimen slide and placed in the apparatus. In one example, control layer 38 with light reflection surface 39 can act as a specimen slide or control layer 38 can operate in conjunction with a specimen slide. In other words, there is a light reflection surface in optical contact with the specimen, such that the evanescent field associated with the total internal reflection interacts with the specimen. In one embodiment, the post-reflection detector assembly 16 has a polarizer 44 and an imaging detector, for example a two-dimensional array detector 46 and preferably a

camera of the CCD or CMOS array type. The processor 18 is a specially programmed computer or processor and output means for processing the imagery into a representation of film thickness variations spatially resolved over the cross-section of the area imaged. This provides information about the presence and composition in the array of substances on the substrate surface for each resolvable point on the surface. Different polarization state changes are included in the cross-section of the reflected beam indicative of the substances on the specimen in the location in the specimen array corresponding to a position in the detector. Processor 18 receives the data as an electrical signal on connector 24 and characterizes the change of polarization state spatially over the two-dimensional array. In processor 18, the analysis and processing is done in one embodiment by comparing the known polarization state of the incoming light from the light source assembly 12 with the changed polarization state of the reflected light 22, spatially resolved two-dimensionally within the beam which provides a map of spatially distributed points or spots in the specimen array. The polarization shift is then analyzed by processor 18 to provide information of the presence and properties of elements in the chemical specimen. Other known techniques, such as null processing can be used to determine the change in polarization state.

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2: Microarray image scanning.

Antibody Array Scanning Service allows customers to send finished antibody array slides to our lab for imaging. This service is free of charge, available to customers who purchased our arrays but have no access to a microarray scanner.

This article has been cited by other articles in PMC. Spectra profiles were obtained from MCR analysis of hyperspectral images from two individual spotted arrays manufactured in-house containing spots of only Cy5 bound to dCTP and Cy5 incorporated into cDNA. Spectral traces are normalized for maximum intensity equal to one Abstract Background Commercial microarray scanners and software cannot distinguish between spectrally overlapping emission sources, and hence cannot accurately identify or correct for emissions not originating from the labeled cDNA. We employed our hyperspectral microarray scanner coupled with multivariate data analysis algorithms that independently identify and quantitate emissions from all sources to investigate three artifacts that reduce the accuracy and reliability of microarray data: Results Here we demonstrate that several common microarray artifacts resulted from the presence of emission sources other than the labeled cDNA that can dramatically alter the accuracy and reliability of the array data. The microarrays utilized in this study were representative of a wide cross-section of the microarrays currently employed in genomic research. These findings reinforce the need for careful attention to detail to recognize and subsequently eliminate or quantify the presence of extraneous emissions in microarray images. Conclusion Hyperspectral scanning together with multivariate analysis offers a unique and detailed understanding of the sources of microarray emissions after hybridization. This opportunity to simultaneously identify and quantitate contaminant and background emissions in microarrays markedly improves the reliability and accuracy of the data and permits a level of quality control of microarray emissions previously unachievable. Using these tools, we can not only quantify the extent and contribution of extraneous emission sources to the signal, but also determine the consequences of failing to account for them and gain the insight necessary to adjust preparation protocols to prevent such problems from occurring. Background Since their introduction in [1], DNA-based microarrays also known as genechips have driven an explosion in functional genomic analyses. All varieties of microarrays have in common the ability to perform binary comparisons of gene expression for a large number of genes simultaneously in a microchip format [2 - 6]. In theory, biological changes should define the limitations of microarray technology, but unfortunately, technological issues have frequently limited the usefulness of microarray data. Non-biological factors including printing artifacts, dye-gene interactions, background emissions, and slide-to-slide variations significantly reduce the ability to accurately monitor changes in gene expression in microarray experiments [4 , 7 - 10]. These experimental factors are common and often laboratory dependant due to the complicated multi-step procedures used in the production, hybridization, and analysis of microarrays. In attempts to minimize the effect of variability due to non-biological sources, a variety of statistical analyses [11 , 12], normalization techniques [13 - 15], and metrics for image quality [16] have been proposed. However, all these analysis techniques have two assumptions: Neither of these assumptions can be validated with current commercial microarray scanners. Commercial scanners are univariate instruments; that is they use filters to pass all photons emitted in a specific wavelength range to a single point detector. This mode of operation can be fast, but it does not allow discrimination of photons by emission source. Thus, it is not possible to distinguish two photons of the similar wavelength that arise from different emitting species if they are passed through the filter for that channel. Many problems that plague microarrays inaccuracies in background correction, dye-gene effects, skew toward one channel, dye crosstalk, and contaminating fluorescence cannot be accurately assessed in data from filter-based microarray scanners due to this limitation and this can lead to erroneous data [9 , 17]. To address these issues, we have developed a hyperspectral-imaging microarray scanner [18] that allows the simultaneous quantification of all fluorescent species, including the spot-localized background leading to a significant improvement in the accuracy of microarray data. The hyperspectral scanner HSS coupled with multivariate data analysis provides in-depth understanding of the signal detected by traditional microarray scanners and can promote improvement in microarray technology and actually improve the quality of

microarray data. The benefits of an additional dimension of spectral information for material science, cytogenetic, and histological applications [19] and live-cell microscopy [20] have been reviewed. However, until our report, hyperspectral imagers have not demonstrated the sensitivity or speed of commercial microarray scanners or the multivariate data analysis capabilities necessary to extract sufficient information from the complex data [21 - 23]. This paper presents the use of the HSS and multivariate data analysis to understand three anomalies commonly seen in microarray data: The unique capability of HSS technology to identify and correct for the presence of these phenomena improves the reliability and accuracy of gene expression data. Results and Discussion Hyperspectral imaging and multivariate data analysis The HSS we have developed is optimized for imaging printed DNA microarrays and excites a sample with a single laser, typically at nm, while recording the emission over a wavelength range from â€” nm in approximately 0. Details of the optical design and characterization of this line-imaging system have been published elsewhere [18]. Additional lasers are available and the wavelength range and spatial and spectral resolution are adjustable. The sensitivity and dynamic range of this HSS is the same as or better than the commercial microarray scanners we have tested for dyes emitting in the green channel of commercial systems such as Cy3 [18]. In comparison studies between an Axon B microarray scanner exciting Cy5 with nm light and the HSS exciting Cy5 with nm light data not shown the HSS was found to be a factor of 6 less sensitive for Cy5 than commercial microarray scanner. However, the signal acquired from Cy5 is sufficient for quantitation by the multivariate algorithms. In addition, for the studies reported in this publication the focus is predominantly on the green channel emissions. In its current configuration the HSS scanner operates at a slightly slower speed of data acquisition scanning at a maximum rate of 0.

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3: DNA microarray - Wikipedia

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Use of the same reference symbols in different figures indicates similar or identical items. It is further noted that the drawings may not be drawn to scale. A polarized light beam of known polarization state is directed into an optical assembly, for example a total internal reflection member TIR member , configured for reflection at a light reflection surface, for example a total internal reflection surface TIR surface , and then exits the optical assembly. In the context of this document, superposition of reflections as encountered at a layered optical structure where the layer thicknesses are smaller than the coherence length of the illuminating light is referred to as a single reflection. The chemical specimen is in place on or above the light reflection surface in the evanescent field of the reflected light beam. After reflection, the beam is passed to a polarization-sensitive two-dimensional detector such as a polarizer and a camera or other types of detectors. This provides a spatially distributed map of change of polarization state in the specimen. A variety of techniques are available to determine the change in polarization such as measuring the deviation from a null condition or by comparing the input polarization state to the output polarization state. The refractive index composition of the materials within the evanescent field determines the change in the polarization state of the beam due to the reflection at the light reflection surface. A two-dimensional variation of this composition within the light reflection surface is associated with a respective variation of the polarization state spatially distributed across the cross-section of the reflected light beam. In one application, the chemical specimen forms a two-dimensional array of molecules referred to herein as receptors and generally referred to as capture agents or affinity agents with specific affinities towards respective other molecules referred to herein as ligands. In this application, the invention is utilized to indicate the presence or absence or rate of binding between ligands and receptors on the array. Such arrays commonly consist of a plurality of discrete specimen spots. The present method and apparatus images the array so as to distinguish each of the discrete specimen spots represented by the local change in polarization state in the cross-section of the reflected beam. It is noted that thickness and refractive index measurements are functions of the electronics of the detector and that spatial resolution is a function of the optics associated with the optical assembly. The invention is particularly useful in applications where the specimen is in an aqueous solution. In a particular application, the present invention is used to determine the presence of biological agents in a solution such as in immunosensor applications by measuring their attachment to antibodies on the TIR surface in the evanescent field. In another application, the present invention is used to determine the presence and structure of nucleic acid sequences in a solution by measuring their attachment to other nucleic acid sequences on the light reflection surface in the evanescent field. Described in more detail below are different embodiments of the invention. As shown in FIG. Data from detector assembly 16 is sent by an electrical signal along a connector 24 to processor 18 such as a specially programmed computer and user access system including an image display. Data can be presented as an image, a data table, a graph, or in other forms. The polarized light source assembly 12 passes polarized light of known polarization state 20, which may be varied or varying to optical assembly 14 where a light beam reflection occurs. Reflected light 22, having a changed polarization state, passes to detector assembly 16, where it is recorded spatially over the cross-section of the beam. The recorded data is sent to processor 18 where the change of polarization state is determined to provide a spatially resolved map of changes in polarization state. Where the specimens are presented as an array of discrete spots, each spot will be imaged for its change in polarization state within the spot area. The polarized light source assembly 12 has a light source 26, a beam forming member 28 if the nature of the light source is such as to make beam forming useful or necessary , a polarizer 30, and an optical retarder The optical assembly 14 has an optical element 34 which has an optical surface Also shown is a control layer 38 over optical surface 36, and between them an index matching substance A specimen 42 is positioned on light reflection surface 39 of control layer 38 in one example. In one embodiment of the invention, optical element 34 is a prism configured along with control

layer 38 in relationship to the incoming light beam 20 and the exiting light beam 22 such that the beam reflects only a single time at light reflection surface 39 and then exits the prism. If the specimen is placed directly on the optical surface 36, then the optical surface 36 would be the light reflection surface. But this is not the usual application, since the specimen such as a biochip is usually prepared more conveniently on a specimen slide and placed in the apparatus. In one example, control layer 38 with light reflection surface 39 can act as a specimen slide or control layer 38 can operate in conjunction with a specimen slide. However constructed, the invention incorporates an optical structure having a light reflection surface and the beam reflects at the reflection surface between entering and leaving the optical structure. In other words, there is a light reflection surface in optical contact with the specimen, such that the evanescent field associated with the total internal reflection interacts with the specimen. In one embodiment, the post-reflection detector assembly 16 has a polarizer 44 and an imaging detector, for example a two-dimensional array detector 46 and preferably a camera of the CCD or CMOS array type. The processor 18 is a specially programmed computer or processor and output means for processing the imagery into a representation of film thickness variations spatially resolved over the cross-section of the area imaged. This provides information about the presence and composition in the array of substances on the substrate surface for each resolvable point on the surface. Different polarization state changes are included in the cross-section of the reflected beam indicative of the substances on the specimen in the location in the specimen array corresponding to a position in the detector. Processor 18 receives the data as an electrical signal on connector 24 and characterizes the change of polarization state spatially over the two-dimensional array. In processor 18, the analysis and processing is done in one embodiment by comparing the known polarization state of the incoming light from the light source assembly 12 with the changed polarization state of the reflected light 22, spatially resolved two-dimensionally within the beam which provides a map of spatially distributed points or spots in the specimen array. The polarization shift is then analyzed by processor 18 to provide information of the presence and properties of elements in the chemical specimen. Other known techniques, such as null processing can be used to determine the change in polarization state. If an incandescent light source is used, an optical filter is also used. In one embodiment, light source 26 for the apparatus is a quasi-monochromatic light source of moderate bandwidth. In accordance with the invention light source 26 is preferably an LED of moderate bandwidth. Preferably the bandwidth is a full width half maximum wavelength in the range of about 10 nmâ€”50 nm, and more preferably a full width half maximum wavelength in the range of about 30 nmâ€”50 nm. In an alternative embodiment, optical retarder 32 can be placed instead to receive the exiting light beam 22 at a location before polarizer In embodiments in which the light source is a laser 50, a moving diffuser 52 is adapted to produce speckle-offsetting fluctuation of the minima and maxima in the speckle pattern caused by the laser. The moving diffuser 52 is attached to a mechanical actuator 54 which is preferably a motor and servo-apparatus for providing the speckle offsetting fluctuations. The light beam then proceeds through the beam-forming element 28, the polarizer 30, and the optical retarder 32, exiting light source assembly 12 as light beam Polarizer 30, in embodiments as shown in FIGS. Polarizer 30 may be of the type having a mechanical actuator driven by a motor control signal so as to enable the variation and selection of the polarization state of the light beam As mentioned above, the optical element 34 of FIG. As noted above, the specimen 42 of FIG. But this is inconvenient and repeated use is likely to degrade the optical quality of the optical surface Therefore, consistent with common practice in which a biochip or other chemical assay specimen is provided, a specimen slide or other supporting apparatus is employed. It is common in a biochip to provide an array of discrete specimen spots supported on a structure for obtaining analysis of each spot. The term total internal reflection optical element refers to known optical elements alone or in combination with other elements which provide the phenomenon known as total internal reflection. A specimen 64 is mounted above a light reflection surface 66, which in one example is the top of control layer The beam 20 enters the optical assembly, is refracted as it enters, and leaves optical member 56 after a single reflection at light reflection surface Other mechanisms for providing total internal reflection and an evanescent field can be employed in practicing this invention as long as the specimen is placed so as to be in the evanescent field associated with the reflection. As seen in FIG. The method and apparatus of the present invention can be used

in combination with biochips of the type having discrete specimen spots or a micro-titer plate containing an array of discrete spots or locations for analysis, where the detected change in polarization state is spatially related to the discrete locations in the reflected beam. Therefore, as used herein the control layer and specimen refers to any type of chemical or biological array that is desired to be examined. The foregoing described apparatus and methods are especially beneficial for imaging materials in an aqueous medium. The invention as described above provides an extremely sensitive optical imaging system for real-time imaging of the binding status of biochip array elements on the surface of an optically transparent material such as a glass or plastic chip. An exemplary monitored array of a 15 mm square inscribed in a 20 mm circular field, with discrete specimen spots of size commensurate with the lateral resolution of the imaging optics, results in fully parallel, continuous real-time readout of up to 5 million sensor fields. The apparatus of FIG. The area imaged could be the entire biochip array or a portion of the entire biochip array. By providing an array of spots of different materials, different constituents in test material flowed over the spots bind in a manner which identifies those constituents. By including in a computer memory the positions of the various materials in the different spots of the array, the image produced by the apparatus of FIG. With the apparatus described, height differences can be imaged dynamically over such short periods of time that intermediate height change readings can be recorded and therefore height change rates can be determined as well as allowing comparison of the rate of height change or intermediate amount of height change among the spots on the biochip array. In another embodiment, an image of a microarray may be obtained by scanning a light beam over the microarray and detecting a polarization change in the light beam for each portion of the array that is interrogated. After exposing the array to molecules of interest under selected test conditions, scanning devices can examine a preselected portion of the array and determine a polarization change at that location. The portion of the array examined may encompass a variety of areas, including in one example an array spot or an equivalent area associated with a pixel or a plurality of pixels of an image, but is at least a resolvable point. Thus, scanning is another method of obtaining a spatially distributed map of polarization changes over a microarray to thereby provide a 2-dimensional image of the microarray. Referring now to FIG. In one embodiment, light source assembly may include a light source for providing a light beam , and a focusing system with focusing optics for directing the light beam from the light source to the reflective surface of optical assembly Light source assembly directs the light beam at a portion of a microarray provided in conjunction with optical assembly and moves the light beam in a scanning manner to interrogate other portions of the microarray. In other words, light source assembly directs a light beam which rapidly scans the light beam back and forth across the reflective surface of optical assembly It is apparent that typical zigzag patterns or other patterns across the microarray may be used to obtain data in a raster fashion. In one example, the light source assembly may provide a light beam to a line or other predetermined portion or section of a microarray and scan a strip of the sample at a time. It is noted that a variety of devices may be employed to generate the sweeping motion of the light beam. In one example, rotating polyhedral mirrors may be employed to scan the light beam across the microarray. In a further example, the light source assembly may also direct the laser beam using a galvanometer mirror that scans the light beam across the surface of the reflective surface of the optical assembly. This generates a rapidly sweeping or rastering beam reflecting from the galvanometer mirror, which is then directed at and swept across the surface of the reflective surface that is to be scanned. Typically, an optical train may be employed between the light source and the galvanometer mirror to assist in directing, focusing, or filtering the beam directed at and reflected from the galvanometer mirror. In addition to providing smaller spot size while not sacrificing scanning field size, the focusing optics of the scanning system may include a telecentric objective lens. This allows undistorted imaging of the flat surface plane, across the entire scanning surface, i. A multi-axis translation stage may also move the microarray to position different portions of the microarray to be scanned while the light beam is stationary or moving. In one example, the translation stage moves the microarray at a constant velocity to allow for continuous integration and processing of data. Detector assembly may be adapted to detect the polarization change of reflected light beam as light beam scans the microarray. The detector assembly may be similar to that previously described above but must be capable of detecting light beams that are scanned across the microarray. Systems may actuate a lens of the

light source assembly or the translation stage carrying the microarray by servomechanism s to bring features into focus by varying the distance between the items. In other words, a control algorithm attempts to hold focus by maintaining the distance between a lens and slide despite asymmetries present in the system. Known feedback logic controllers may be used to accomplish this goal, including Proportional-Integral and Proportional-Integral-Derivative electronic feedback controllers. Auto-focusing features to maintain the sample in the focal plane of the light beam throughout the scanning process may be included with the light source assembly e.

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4: SpotLightâ„¢ 2 and Turbo Microarray Fluorescence Scanners by Arrayit

The microarray platform is a powerful tool for conducting largeâ€•scale, highâ€•throughput gene expression experiments. However, careful attention to detail throughout the five major steps in the microarray processâ€”design, printing, hybridization, scanning, and analysisâ€”must be used to ensure that reliable and accurate conclusions are obtained from data.

Other References Tadashi Saitoh, et al. Gang Jin et al. Max Born et al. Danny Van Noort et al. Jinyu Wang "Waveguide Ellipsometry Biosensors: Ulf Jonsson et al. Johnsson, Ulf et al. Harcourt Brace Jovanovich, Publishers. CH Streibel et al. Haken Nygren et al. Hakan Nygren et al. Martin Malmsten et al. Pentti Tengvall et al. Huaiyou Wang et al. F Mandenius et al. Rudolf Oldenbourg "Metamorph Imaging System", http: Rudolf Oldenbourg "A New view on polarization microscopy", Nature, vol. Dirk Honig et al. Pentti Tengvalle et al. Arwin "Spectroscopic ellipsometry and biology: Christopher Palmer "Diffraction Grating Handbook", pp. Attorney, Agent or Firm: This application is also a continuation-in-part of U. An apparatus for scanning, comprising: The apparatus of claim 1, wherein the light source comprises a quasi-monochromatic light source of moderate bandwidth. The apparatus of claim 2, wherein the quasi-monochromatic light source of moderate bandwidth is a light-emitting diode LED or a superluminescent diode SLD. The apparatus of claim 2, wherein the quasi-monochromatic light source of moderate bandwidth comprises an incandescent source and an optical filter, the light emitted from the incandescent source passing through the optical filter, the optical filter limiting the wavelengths of the light transmitted through the optical filter such as to constitute quasi-monochromatic light of moderate bandwidth. The apparatus of claim 1, wherein the light source comprises a laser emitting substantially coherent light, and further comprising an optical diffuser mechanically attached to a mechanical actuator, the light emitted from the laser passing through the diffuser, the diffuser being moved with respect to the laser by the actuator, the movement of the diffuser with respect to the laser creating fluctuations in the speckle pattern of light detected by the detector, the fluctuations being adapted to remove speckle effects from the light detected by the detector. The apparatus as in claim 5, wherein the mechanical actuator is a motor rotating the optical diffuser. The apparatus of claim 1, wherein the light source comprises a beam forming system, the beam forming system causing the light emerging from the light source to be collimated. The apparatus of claim 1, wherein the light source comprises an optical polarizer. The apparatus of claim 8, wherein the optical polarizer is controllably rotated by a motor. The apparatus of claim 1, wherein the light source comprises an optical retarder, the retarder introducing an optical phase shift between two orthogonal components of light passing through the retarder. The apparatus of claim 10, wherein the optical retarder is controllably rotated by a motor. The apparatus of claim 10, wherein the optical retarder changes retardance according to an externally introduced physical parameter. The apparatus of claim 1, wherein the optical assembly comprises an optical prism. The apparatus of claim 1, wherein the specimen array comprises a two-dimensional array formed of multiple fields comprising biomolecular substances. The apparatus of claim 1, wherein the detector comprises a two-dimensional array detector. The apparatus of claim 1, wherein the light beam is in the form of a line. The apparatus of claim 1, further comprising a translation stage operably coupled to the optical assembly. The apparatus of claim 1, further comprising an actuator operably coupled to the light source. The apparatus of claim 1, further comprising an actuator operably coupled to the detector. The apparatus of claim 1, further comprising a processor coupled to the detector, the processor processing the signal from the detector to obtain a representation of the optical phase shift occurring in the portion of the specimen array. The apparatus of claim 1, further comprising a processor coupled to the detector, the processor processing a plurality of signals related to spatially distributed polarization changes as the light beam scans the specimen array to thereby provide an image of the specimen array. The apparatus of claim 23, wherein the processor provides feedback to reduce or increase resolution over a portion of the microarray. The apparatus of claim 23, wherein the processor provides feedback to skip scanning over a portion of the microarray. The apparatus of claim 23, wherein the processor provides feedback to increase the frequency of scanning over a portion of the microarray. The apparatus of claim 27, wherein the processor

provides feedback to reduce or increase resolution over a portion of the microarray. The apparatus of claim 27, wherein the processor provides feedback to skip scanning over a portion of the microarray. The apparatus of claim 27, wherein the processor provides feedback to decrease or increase the frequency of scanning over a portion of the microarray. A method of imaging, comprising: The method of claim 31, wherein the specimen array is in a micro-titer plate. The method of claim 33, further comprising: The method of claim 31, wherein the specimen array is a series of discrete specimen spots. The method of claim 35, further comprising analyzing the polarization changes to determine the binding characteristics of each discrete specimen spot. The method of claim 31, wherein a specimen array having no molecular tagging is placed in the evanescent field. A method of scanning, comprising: The method of claim 38, wherein the subsequent scanning decreases or increases resolution over a portion of the microarray. The method of claim 38, wherein the subsequent scanning skips over a portion of the microarray. The method of claim 38, wherein the subsequent scanning decreases or increases the frequency of scanning over a portion of the microarray. Discussion of the Related Art This invention relates to imaging or scanning of a biochip also referred to as a gene chip, protein chip, microarray and others. The formation of an array of biologically or chemically active spots on the surface of a substrate for identifying constituents in test material brought into contact with the array is well known. Typically, such processes require spots of, for example, oligonucleotides, cloned DNA, antibodies, peptides, receptors, enzymes, inhibitors, etc. An apparatus and method which provide for microarray scanning at high resolution and speed is needed and desirable for imaging of the microarray. SUMMARY Scanning methods and apparatus may be used to accumulate and process data regarding change in polarization state for individual points or lines or other portion of the microarray to image the microarray at high resolution and speed. The total internal reflection at any point within the cross-section of the light beam causes a phase shift between the light component polarized in the plane of incidence and the component polarized perpendicular to the plane of incidence. The reflected light is detected by a polarization-sensitive detector such as a two dimensional array detector and the signal from this detector is then processed in a computer to provide information about substances on the surface of the specimen. Spatially distributed changes in polarization state over the microarray are indicative of the substances in the specimen in the location in the specimen array corresponding to a position in the detector. In accordance with one embodiment of the present disclosure, an apparatus for scanning is provided, comprising a light source emitting a polarized light beam, and an optical assembly having a surface adapted to allow placing thereon a specimen array, the light beam from the light source being reflected by the surface to provide an evanescent field over a portion of the specimen array such that the portion of the specimen array in the evanescent field causes a polarization change in the light beam. The apparatus further includes a detector positioned to detect the polarization change in the light beam as the light beam is scanned over the specimen array. In accordance with another embodiment of the present disclosure, an apparatus for scanning is provided including a processor to process a plurality of signals related to spatially distributed polarization changes to thereby provide feedback for subsequent scanning of the specimen array. In accordance with yet another embodiment of the present disclosure, a method of imaging is provided, comprising passing a polarized light beam into an optical structure for reflection at a surface of the optical structure to provide an evanescent field over a portion of a specimen array, the portion of the specimen array in the evanescent field causing a polarization change in the light beam. The method further includes detecting the polarization change in the light beam as the light beam scans the specimen array, and processing a plurality of signals related to spatially distributed polarization changes to thereby provide an image of the specimen array. In accordance with yet another embodiment of the present disclosure, a method of scanning is provided, including processing a plurality of signals related to spatially distributed polarization changes to thereby provide feedback for subsequent scanning of the specimen array. The apparatus and method of the present disclosure are especially adapted for imaging or scanning material in an aqueous solution. It is furthermore particularly suited for detecting attachment and detachment of analytes to a two-dimensional biomolecular array positioned on a light reflection surface as part of a molecular thin film system. In various applications a plurality of discrete specimen spots are presented in an array, where the method and apparatus will image or scan the array so as to distinguish each of the discrete specimen spots. Advantageously,

fluorescence or molecular tagging is not necessary but optional for use in this invention. These and other features and advantages of the present invention will be more readily apparent from the detailed description of the embodiments set forth below taken in conjunction with the accompanying drawings. Use of the same reference symbols in different figures indicates similar or identical items. It is further noted that the drawings may not be drawn to scale. A polarized light beam of known polarization state is directed into an optical assembly, for example a total internal reflection member TIR member , configured for reflection at a light reflection surface, for example a total internal reflection surface TIR surface , and then exits the optical assembly. In the context of this document, superposition of reflections as encountered at a layered optical structure where the layer thicknesses are smaller than the coherence length of the illuminating light is referred to as a single reflection. The chemical specimen is in place on or above the light reflection surface in the evanescent field of the reflected light beam. After reflection, the beam is passed to a polarization-sensitive two-dimensional detector such as a polarizer and a camera or other types of detectors. This provides a spatially distributed map of change of polarization state in the specimen. A variety of techniques are available to determine the change in polarization such as measuring the deviation from a null condition or by comparing the input polarization state to the output polarization state. The refractive index composition of the materials within the evanescent field determines the change in the polarization state of the beam due to the reflection at the light reflection surface. A two-dimensional variation of this composition within the light reflection surface is associated with a respective variation of the polarization state spatially distributed across the cross-section of the reflected light beam. In one application, the chemical specimen forms a two-dimensional array of molecules referred to herein as receptors and generally referred to as capture agents or affinity agents with specific affinities towards respective other molecules referred to herein as ligands. In this application, the invention is utilized to indicate the presence or absence or rate of binding between ligands and receptors on the array. Such arrays commonly consist of a plurality of discrete specimen spots. The present method and apparatus images the array so as to distinguish each of the discrete specimen spots represented by the local change in polarization state in the cross-section of the reflected beam. It is noted that thickness and refractive index measurements are functions of the electronics of the detector and that spatial resolution is a function of the optics associated with the optical assembly. The invention is particularly useful in applications where the specimen is in an aqueous solution. In a particular application, the present invention is used to determine the presence of biological agents in a solution such as in immunosensor applications by measuring their attachment to antibodies on the TIR surface in the evanescent field. In another application, the present invention is used to determine the presence and structure of nucleic acid sequences in a solution by measuring their attachment to other nucleic acid sequences on the light reflection surface in the evanescent field. Described in more detail below are different embodiments of the invention. As shown in FIG.

MICROARRAY IMAGE SCANNING pdf

5: USB2 - Microarray scanning - Google Patents

Specification. Arrayit InnoScanÂ® and AL. Arrayit InnoScanÂ® AL. General Description. Characterized by simplicity of use, competitive price and superior image quality, ArrayitÂ® InnoScanÂ® scanners are ideal instruments for scanning most high density microarrays available on the market.

Gene expression profiling In an mRNA or gene expression profiling experiment the expression levels of thousands of genes are simultaneously monitored to study the effects of certain treatments, diseases , and developmental stages on gene expression. For example, microarray-based gene expression profiling can be used to identify genes whose expression is changed in response to pathogens or other organisms by comparing gene expression in infected to that in uninfected cells or tissues. Chromatin immunoprecipitation on Chip DNA sequences bound to a particular protein can be isolated by immunoprecipitating that protein ChIP , these fragments can be then hybridized to a microarray such as a tiling array allowing the determination of protein binding site occupancy throughout the genome. DamID Analogously to ChIP , genomic regions bound by a protein of interest can be isolated and used to probe a microarray to determine binding site occupancy. SNP detection Identifying single nucleotide polymorphism among alleles within or between populations. Alternative splicing detection An exon junction array design uses probes specific to the expected or potential splice sites of predicted exons for a gene. It is of intermediate density, or coverage, to a typical gene expression array with 1â€”3 probes per gene and a genomic tiling array with hundreds or thousands of probes per gene. It is used to assay the expression of alternative splice forms of a gene. Exon arrays have a different design, employing probes designed to detect each individual exon for known or predicted genes, and can be used for detecting different splicing isoforms. Fusion genes microarray A Fusion gene microarray can detect fusion transcripts, e. The principle behind this is building on the alternative splicing microarrays. The oligo design strategy enables combined measurements of chimeric transcript junctions with exon-wise measurements of individual fusion partners. Tiling array Genome tiling arrays consist of overlapping probes designed to densely represent a genomic region of interest, sometimes as large as an entire human chromosome. The purpose is to empirically detect expression of transcripts or alternatively spliced forms which may not have been previously known or predicted. Double-stranded B-DNA microarrays Right-handed double-stranded B-DNA microarrays can be used to characterize novel drugs and biologicals that can be employed to bind specific regions of immobilized, intact, double-stranded DNA. This approach can be used to inhibit gene expression. This approach can be used to discover new drugs and biologicals that have the ability to inhibit gene expression. Fabrication[edit] Microarrays can be manufactured in different ways, depending on the number of probes under examination, costs, customization requirements, and the type of scientific question being asked. Arrays from commercial vendors may have as few as 10 probes or as many as 5 million or more micrometre-scale probes. The probes are synthesized prior to deposition on the array surface and are then "spotted" onto glass. A common approach utilizes an array of fine pins or needles controlled by a robotic arm that is dipped into wells containing DNA probes and then depositing each probe at designated locations on the array surface. The resulting "grid" of probes represents the nucleic acid profiles of the prepared probes and is ready to receive complementary cDNA or cRNA "targets" derived from experimental or clinical samples. This technique is used by research scientists around the world to produce "in-house" printed microarrays from their own labs. These arrays may be easily customized for each experiment, because researchers can choose the probes and printing locations on the arrays, synthesize the probes in their own lab or collaborating facility , and spot the arrays. They can then generate their own labeled samples for hybridization, hybridize the samples to the array, and finally scan the arrays with their own equipment. This provides a relatively low-cost microarray that may be customized for each study, and avoids the costs of purchasing often more expensive commercial arrays that may represent vast numbers of genes that are not of interest to the investigator. Publications exist which indicate in-house spotted microarrays may not provide the same level of sensitivity compared to commercial oligonucleotide arrays, [15] possibly owing to the small batch sizes and reduced printing efficiencies when compared to industrial manufactures of oligo arrays. In

oligonucleotide microarrays, the probes are short sequences designed to match parts of the sequence of known or predicted open reading frames. Although oligonucleotide probes are often used in "spotted" microarrays, the term "oligonucleotide array" most often refers to a specific technique of manufacturing. Oligonucleotide arrays are produced by printing short oligonucleotide sequences designed to represent a single gene or family of gene splice-variants by synthesizing this sequence directly onto the array surface instead of depositing intact sequences. Sequences may be longer mer probes such as the Agilent design or shorter mer probes produced by Affymetrix depending on the desired purpose; longer probes are more specific to individual target genes, shorter probes may be spotted in higher density across the array and are cheaper to manufacture. One technique used to produce oligonucleotide arrays include photolithographic synthesis Affymetrix on a silica substrate where light and light-sensitive masking agents are used to "build" a sequence one nucleotide at a time across the entire array. After many repetitions, the sequences of every probe become fully constructed. The two Cy-labeled cDNA samples are mixed and hybridized to a single microarray that is then scanned in a microarray scanner to visualize fluorescence of the two fluorophores after excitation with a laser beam of a defined wavelength. Relative intensities of each fluorophore may then be used in ratio-based analysis to identify up-regulated and down-regulated genes. The degree of hybridization between the spike-ins and the control probes is used to normalize the hybridization measurements for the target probes. Although absolute levels of gene expression may be determined in the two-color array in rare instances, the relative differences in expression among different spots within a sample and between samples is the preferred method of data analysis for the two-color system. Examples of providers for such microarrays includes Agilent with their Dual-Mode platform, Eppendorf with their DualChip platform for colorimetric Silverquant labeling, and TeleChem International with Arrayit. In single-channel microarrays or one-color microarrays, the arrays provide intensity data for each probe or probe set indicating a relative level of hybridization with the labeled target. However, they do not truly indicate abundance levels of a gene but rather relative abundance when compared to other samples or conditions when processed in the same experiment. Each RNA molecule encounters protocol and batch-specific bias during amplification, labeling, and hybridization phases of the experiment making comparisons between genes for the same microarray uninformative. The comparison of two conditions for the same gene requires two separate single-dye hybridizations. One strength of the single-dye system lies in the fact that an aberrant sample cannot affect the raw data derived from other samples, because each array chip is exposed to only one sample as opposed to a two-color system in which a single low-quality sample may drastically impinge on overall data precision even if the other sample was of high quality. Another benefit is that data are more easily compared to arrays from different experiments as long as batch effects have been accounted for. One channel microarray may be the only choice in some situations.

6: US Patent # 7,, Microarray scanning - www.enganchecubano.com

Using the optical filter functions of the Axon B microarray scanner, HSS images can be scaled to match the total intensity of each of the commercial scanner channels, thus providing a direct comparison to the commercial scanner results.

This article has been cited by other articles in PMC. Abstract Background Commercial microarray scanners and software cannot distinguish between spectrally overlapping emission sources, and hence cannot accurately identify or correct for emissions not originating from the labeled cDNA. We employed our hyperspectral microarray scanner coupled with multivariate data analysis algorithms that independently identify and quantitate emissions from all sources to investigate three artifacts that reduce the accuracy and reliability of microarray data: Results Here we demonstrate that several common microarray artifacts resulted from the presence of emission sources other than the labeled cDNA that can dramatically alter the accuracy and reliability of the array data. The microarrays utilized in this study were representative of a wide cross-section of the microarrays currently employed in genomic research. These findings reinforce the need for careful attention to detail to recognize and subsequently eliminate or quantify the presence of extraneous emissions in microarray images. Conclusion Hyperspectral scanning together with multivariate analysis offers a unique and detailed understanding of the sources of microarray emissions after hybridization. This opportunity to simultaneously identify and quantitate contaminant and background emissions in microarrays markedly improves the reliability and accuracy of the data and permits a level of quality control of microarray emissions previously unachievable. Using these tools, we can not only quantify the extent and contribution of extraneous emission sources to the signal, but also determine the consequences of failing to account for them and gain the insight necessary to adjust preparation protocols to prevent such problems from occurring. Background Since their introduction in [1], DNA-based microarrays also known as genechips have driven an explosion in functional genomic analyses. All varieties of microarrays have in common the ability to perform binary comparisons of gene expression for a large number of genes simultaneously in a microchip format [2 - 6]. In theory, biological changes should define the limitations of microarray technology, but unfortunately, technological issues have frequently limited the usefulness of microarray data. Non-biological factors including printing artifacts, dye-gene interactions, background emissions, and slide-to-slide variations significantly reduce the ability to accurately monitor changes in gene expression in microarray experiments [4 , 7 - 10]. These experimental factors are common and often laboratory dependant due to the complicated multi-step procedures used in the production, hybridization, and analysis of microarrays. In attempts to minimize the effect of variability due to non-biological sources, a variety of statistical analyses [11 , 12], normalization techniques [13 - 15], and metrics for image quality [16] have been proposed. However, all these analysis techniques have two assumptions: Neither of these assumptions can be validated with current commercial microarray scanners. Commercial scanners are univariate instruments; that is they use filters to pass all photons emitted in a specific wavelength range to a single point detector. This mode of operation can be fast, but it does not allow discrimination of photons by emission source. Thus, it is not possible to distinguish two photons of the similar wavelength that arise from different emitting species if they are passed through the filter for that channel. Many problems that plague microarrays inaccuracies in background correction, dye-gene effects, skew toward one channel, dye crosstalk, and contaminating fluorescence cannot be accurately assessed in data from filter-based microarray scanners due to this limitation and this can lead to erroneous data [9 , 17]. To address these issues, we have developed a hyperspectral-imaging microarray scanner [18] that allows the simultaneous quantification of all fluorescent species, including the spot-localized background leading to a significant improvement in the accuracy of microarray data. The hyperspectral scanner HSS coupled with multivariate data analysis provides in-depth understanding of the signal detected by traditional microarray scanners and can promote improvement in microarray technology and actually improve the quality of microarray data. The benefits of an additional dimension of spectral information for material science, cytogenetic, and histological applications [19] and live-cell microscopy [20

] have been reviewed. However, until our report, hyperspectral imagers have not demonstrated the sensitivity or speed of commercial microarray scanners or the multivariate data analysis capabilities necessary to extract sufficient information from the complex data [21 - 23]. This paper presents the use of the HSS and multivariate data analysis to understand three anomalies commonly seen in microarray data: The unique capability of HSS technology to identify and correct for the presence of these phenomena improves the reliability and accuracy of gene expression data. Results and Discussion Hyperspectral imaging and multivariate data analysis The HSS we have developed is optimized for imaging printed DNA microarrays and excites a sample with a single laser, typically at nm, while recording the emission over a wavelength range from â€” nm in approximately 0. Details of the optical design and characterization of this line-imaging system have been published elsewhere [18]. Additional lasers are available and the wavelength range and spatial and spectral resolution are adjustable. The sensitivity and dynamic range of this HSS is the same as or better than the commercial microarray scanners we have tested for dyes emitting in the green channel of commercial systems such as Cy3 [18]. In comparison studies between an Axon B microarray scanner exciting Cy5 with nm light and the HSS exciting Cy5 with nm light data not shown the HSS was found to be a factor of 6 less sensitive for Cy5 than commercial microarray scanner. However, the signal acquired from Cy5 is sufficient for quantitation by the multivariate algorithms. In addition, for the studies reported in this publication the focus is predominantly on the green channel emissions. In its current configuration the HSS scanner operates at a slightly slower speed of data acquisition scanning at a maximum rate of 0.

7: Hyperspectral microarray scanning: impact on the accuracy and reliability of gene expression data

The GenePixÂ® B Microarray Scanner is a benchmark for quality, reliability and ease-of-use in microarray scanning technology. Coupled with GenePixÂ® ProMicroarray Image Analysis Software and AcuityÂ® Microarray Informatics Software, the GenePix System sets the highest standards in the acquisition and analysis of data from all types of.

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