MOLECULAR READER

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to U.S. Provisional Application No. 61/161,642, filed on Mar. 19, 2009, the entire contents of which are incorporated herein by reference.

STATEMENT AS TO FEDERALLY SPONSORED RESEARCH

This invention was made with Government support under National Institutes of Health Grant No. 5 U01 DE 017788-03. The Government has certain rights in this invention.

TECHNICAL FIELD

This disclosure relates to detection of chemicals, biological molecules and portions of molecules.

BACKGROUND

Conventional methods for detecting chemicals and biological molecules such as proteins and nucleic acids can be time-consuming and can require expensive laboratory equipment. Detection of such molecules, or fragments thereof, can provide important diagnostic tools for medical testing, security screening, environmental testing, and other applications.

SUMMARY

The ability to detect chemicals and biological molecules with a mechanically robust, portable device, usable with minimal training, can allow analyses to be done outside a traditional laboratory setting. In general, the disclosure discusses a system that allows enables detection of chemicals, biological molecules and portions of molecules. The system can perform optical imaging functions and small-volume fluidic functions, and includes:

In general, in a first aspect, the disclosure features a system that includes: (a) a support apparatus configured to detachably receive a chip; (b) a plurality of movable pins extendible from a first position to a second position, where (i) in the first position, the movable pins do not contact the chip when the chip is positioned on the support apparatus, and (ii) in the second position, the movable pins contact electrical terminals of one or more heating elements within the chip when the chip is positioned on the support apparatus; (c) a compact, high-performance optical system including (i) a radiation source configured to direct radiation to be incident on the chip when the chip is positioned on the support apparatus, and (ii) an imaging detector configured to detect radiation emitted from the chip when the chip is positioned on the support apparatus; and (d) an electronic processor in electrical communication with the plurality of movable pins and the detector, where the electronic processor is configured to detect molecules in a sample positioned within the chip by analyzing the detected radiation, and to determine a temperature of the chip by measuring an electrical resistance between two of the multiple pins connected to the electrical terminals.

In one aspect, an apparatus includes: a compact, portable radiation source/detection system for acquiring a magnified optical image of an object. The compact, portable radiation source/detection system includes: at least one radiation source which projects radiation onto the object; an imaging detector; optics for imaging radiation emitted, reflected, scattered, or otherwise altered by the object in response to the radiation source to the imaging detector to produce the magnified optical image of the object on the detector; and one or more optical filters which prevent >90% of the radiation from the radiation source from being detected by the detector, while allowing the radiation emitted, reflected, scattered, or otherwise altered by the object to be detected by the detector. In some embodiments, the compact, portable radiation source/detection system is rugged. In some embodiments, the optics, the imaging detector and the one or more optical filters are configured to form a magnified fluorescence image of the object on the detector.

In one aspect, systems include a radiation source/detection system for acquiring a magnified optical image of an object; at least one radiation source which projects light onto the object; a lens assembly including at least one optical element for collecting radiation emitted, reflected, scattered, or otherwise altered by the object; a lens assembly including at least one optical element for conveying the image or altered radiation to the detector; a detector for collecting light emitted, reflected, scattered, or otherwise altered by the object; one or more optical filters which prevent >90% of radiation from at least one radiation source from being detected by the detector, while allowing radiation emitted, reflected, scattered, or otherwise altered by the object to be detected.

Embodiments of the systems and apparatus can include one or more of the following features.

The system can include a miniaturized optical subsystem for high-resolution 2-D imaging. The optical subsystem can include one or more radiation sources. Each radiation source provides light to an object or area of interest, allowing the object to be imaged.

In some embodiments, systems also include a support apparatus configured to detachably receive a microfluidic chip. In some cases, systems also include an electronic processor in electrical communication with the radiation sources and the detector, wherein the electronic processor is configured to process the detected radiation or image. Systems can also include a movable lens system electrically coupled to the electronic processor. During use, the electronic processor can be configured to adjust a depth of focus of the detected radiation by translating at least one lens of the movable lens system. The movable lens system can include a movable actuator, a movable objective lens, and a pivoting member connected to the actuator and to the objective lens, and wherein during use the electronic processor adjusts the depth of focus by adjusting an extension of the actuator.

In some cases, the detector is configured to acquire an image of the chip when the chip is received by the support apparatus, and wherein the electronic processor is configured to determine the position of the chip based on the image. The electronic processor can be configured to determine whether the chip is positioned correctly based on the image.

In some embodiments, the detected radiation comprises fluorescence emission from a sample positioned within the chip.

In some embodiments, the electronic processor is configured to detect two or more different types of molecules in a sample positioned within the chip by analyzing the detected radiation at one central wavelength. In some cases, the electronic processor is configured to detect at least one of molecules comprising amino acids and molecules comprising nucleic acids in a sample positioned within the chip.

The optical subsystem can further include a detector which can be configured to acquire an image of the object or an area of interest, and the electronic processor can be configured to determine the position of the chip based on the image. The