

## SYSTEM AND METHOD FOR DETECTING MULTIPLE MOLECULES IN ONE ASSAY

### RELATED APPLICATIONS

[0001] This application claims benefit of priority to U.S. Provisional Patent Application Ser. Nos. 61/383,150, filed Sep. 15, 2010, 61/391,909, filed Oct. 11, 2010, 61/438,864, filed Feb. 2, 2011, 61/468,650, filed Mar. 29, 2011, 61/468,659, filed Mar. 29, 2011, 61/469,954, filed Mar. 31, 2011, and 61/505,421, filed Jul. 7, 2011. All of the aforementioned applications are incorporated herein by reference.

### GOVERNMENT INTEREST

[0002] This invention was made with government support under award number A10068543 awarded by the National Institute of Health. The government has certain rights in the invention.

### FIELD OF THE INVENTION

[0003] The present disclosure pertains to diagnosis of disease. More particularly, the disclosure relates to the manufacture and use of certain system for rapid detection of multiple disease markers. A system for detection of analytes, including those identified for immunodiagnostic applications, is disclosed. The system includes a cartridge, containing an optical waveguide, and a reader instrument, containing an imaging system and a light source for reading light signal from an analyte-containing cartridge.

### BACKGROUND

[0004] Early detection of a disease is often critical for successful control and treatment of the disease. Providing accurate, high speed, and low cost blood analysis, infection diagnosis, pathogen detection, or other biological or chemical analyte detection remains a major challenge for health providers and hazardous response teams. This challenge is particularly acute for point-of-care ("POC") environments, where extreme or highly variable environmental conditions are common, testers may have limited training, and practice of test procedures may be significantly different between testers. Such variation is of particular concern for tests offering quantitative or semi-quantitative results, which can critically depend on standardized sample preparation and read-out.

[0005] A case in point is the diagnosis of infectious diseases such as Acquired Immune Deficiency Syndrome ("AIDS"), which may be spread rapidly among the population if the infection is not detected early. Partly because of their compromised immune system, AIDS patients are usually more vulnerable to a number of co-infections, which account for a significant fraction of human immunodeficiency virus ("HIV") associated morbidity and mortality. Substantial amount of time and resources have been invested in developing a host of HIV screening and diagnostic techniques. However, recurring challenges remain as to how to rapidly identify HIV infection and the various co-infections. Existing diagnoses for multiple co-infections typically require use of a number of different serological diagnostic tools, which render the tests too costly and complex for a POC setting. This problem is exacerbated in countries where resource is limited and HIV prevalence is high.

[0006] As an example, the ability to diagnose HIV and opportunistic infections simultaneously at the point-of-care

should lead to more effective therapy decisions and improved linkage to care. System utility is demonstrated for a multiplexed HIV-1/syphilis/hepatitis C virus ("HCV") assay using a combination of clinical sample collections. The ability of the disclosed system to provide quantitative read-outs may also lead to more effective data sharing among the various care-providers, commercial vendors, government entities, and non-profit organizations.

[0007] Multi-analyte testing for AIDS and its co-infections is important for the development of individualized management of HIV-1 infections and its common co-pathogens. At the time of HIV diagnosis, the standard-of-care may include determination of common co-infections such as HCV, hepatitis B virus ("HBV"), *Toxoplasma gondii* ("*T. gondii*"), *Treponema pallidum* ("*T. pallidum*", causative organism of syphilis), and cytomegalovirus ("CMV"). Co-infection information may be used for treatment (as in the case of *T. pallidum*), vaccinations (as in the case of HBV) and prophylaxis (in the case of *T. gondii*). The multiplexed system described here has the potential to offer a combination of critical tests which detect multiple pathogens in a single assay.

[0008] Increased access to anti-retroviral therapy in resource limited settings, and in particular sub-Saharan Africa, has had a major impact on morbidity and mortality from AIDS. By the end of 2009, over 5 million people living in low and middle income countries were receiving anti-retroviral therapy. By most estimates, even before treatment recommendations were revised to encourage the initiation of antiretroviral therapy at higher CD4 cell counts, contemporary anti-retroviral therapy was only reaching 30-40% of those needing therapy. In all likelihood, there will continue to be a substantial gap between the number of people needing antiretroviral therapy and the resources available to treat them. In order to maximize the benefits from the resources available, it is essential that anti-retroviral therapy be delivered as efficiently as possible to those most likely to benefit. A multiplex platform that provides rapid and accurate information about critical co-infections may help prioritize those who should be treated immediately and may also provide guidance on anti-retroviral drug selection.

[0009] In addition to anti-viral treatment decisions based on improved co-infection information, the ability to simultaneously detect markers for multiple pathogens in the same sample offers diagnostic advantages. It is well known that HIV infection complicates HCV serodiagnosis. An HIV/HCV co-infection test may help identify infections that were too difficult to characterize at the time of initial screening.

[0010] One widely adopted solution for use in primarily qualitative testing (i.e., identifying whether or not an analyte is present at some threshold value) is commonly referred to as a rapid diagnostic test ("RDT"). While a RDT can provide the advantages of low per-test cost, simple operation, and minimal or no required instrumentation, there are also significant limitations. RDTs are often configured to test for only a single analyte, so multiple devices are needed to support co-infection testing, which can be prohibitive from test cost, personnel training, and results management perspectives. Many RDTs are based on chromatographic or lateral flow technology, in which whole or processed blood or other sample, such as urine, is introduced into an absorbent test strip that contains an immunologically-responsive analyte detector. If the analyte is present, a visually-perceptible color change in a portion of the test strip can indicate presence of the analyte and, in certain conditions, user or automated review of the color