Claims

1. A dispensing apparatus for dispensing biofluid, the dispensing apparatus comprising:

a cartridge comprising:

a receiving chamber for receiving a bulk sample of biofluid;

a set of metering chambers fluidically communicative with the receiving chamber, each metering chamber configured for holding a predefined volume of biofluid sample apportioned from the biofluid bulk sample; and

each metering chamber comprising an outlet for dispensing the respective biofluid sample and a dispensing filter for filtering the respective biofluid sample during dispensing,

wherein the biofluid samples in the metering chambers are dispensable through the outlets by applying vacuum pressure in the cartridge, the dispensing filters preventing dispensing of the biofluid samples in absence of the vacuum pressure.

2. The dispensing apparatus according to claim 1, wherein the dispensing filters comprise a set of frit filters and/or a set of semipermeable membranes.

~~3. The dispensing apparatus according to claim 2, wherein the frit filters comprise fritted glass and/or sintered frit.~~

~~4. The dispensing apparatus according to claim 2 or 3, wherein the semipermeable membranes are made of a hydrophobic material.~~

~~5~~3. The dispensing apparatus according to ~~any one of~~ claim~~s~~ 1 ~~to 4~~or 2, wherein the dispensing filters are configured to withhold particulate matter of at least 2 µm.

~~6~~4. The dispensing apparatus according to any one of claims 1 to ~~5~~3, further comprising a cuvette casing for removably receiving a set of cuvettes, the cartridge and cuvette casing removably coupleable to each other such that each cuvette is

joined to a respective one of the metering chambers for receiving the respective filtered biofluid sample.

~~7~~5. The dispensing apparatus according to claim ~~6~~4, further comprising the cuvettes in the cuvette casing, wherein the cartridge and cuvette casing are removably coupled to each other and the cuvettes are removably coupled to the metering chambers.

~~8~~6. The dispensing apparatus according to claim ~~7~~5, wherein each cuvette contains a magnetic object for facilitating physical mixing of the biofluid sample and a reagent in the cuvette.

~~9. The dispensing apparatus according to claim 7 or 8, wherein each cuvette comprises a vent hole to facilitate evacuation of air bubbles when the vacuum pressure is applied.~~

~~10. The dispensing apparatus according to claim 9, wherein the vent hole comprises a hydrophobic membrane.~~

~~11. The dispensing apparatus according to any one of claims 6 to 10, further comprising a set of gaskets disposed between the cartridge and cuvette casing for sealing engagement therebetween.~~

~~12. The dispensing apparatus according to claim 11, wherein the gaskets comprise a set of holes to facilitate dispensing of the filtered biofluid samples into the cuvettes.~~

~~13~~7. The dispensing apparatus according to any one of claims 1 to ~~12~~6, further comprising a cartridge lid for sealing the cartridge.

~~14~~8. The dispensing apparatus according to claim ~~13~~7, wherein the cartridge lid comprises a vacuum port for receiving a vacuum actuator that is actuatable by application of the vacuum pressure.

~~15. The dispensing apparatus according to claim 13 or 14, wherein the cartridge lid comprises a set of air vents for venting air during application of the vacuum pressure.~~

~~16. The dispensing apparatus according to any one of claims 13 to 15, wherein the cartridge lid comprises a filling port for transferring the biofluid bulk sample to the receiving chamber.~~

~~17. The dispensing apparatus according to claim 16, wherein the cartridge lid comprises a filling filter engageable with the filling port for pre-filtration of the biofluid bulk sample.~~

~~18. The dispensing apparatus according to claim 17, wherein the filling filter comprises a set of frit filters and/or a set of semipermeable membranes.~~

~~19. The dispensing apparatus according to any one of claims 1 to 18, wherein each metering chamber comprises a set of ribs for supporting the respective dispensing filter.~~

~~20. The dispensing apparatus according to claim 19, wherein the ribs are arranged to facilitate communication of the biofluid sample to a centre of the outlet.~~

~~21~~9. The dispensing apparatus according to any one of claims 1 to ~~20~~8, wherein each metering chamber comprises a retainer ring fitted onto the respective dispensing filter to prevent backflow of the biofluid sample.

~~22~~10. The dispensing apparatus according to any one of claims 1 to ~~21~~9, further comprising a piston assembly disposed in the cartridge, the piston assembly actuatable by application of the vacuum pressure for dispensing the biofluid samples.

~~23. The dispensing apparatus according to claim 22, wherein the piston assembly comprises a set of pistons, each piston displaceable into a respective one of the metering chambers for dispensing the respective biofluid sample.~~

24. The dispensing apparatus according to claim 22 or 23, wherein the piston assembly is displaced by a vacuum actuator actuated by application of the vacuum pressure.

25. The dispensing apparatus according to any one of claims 1 to 24, further comprising a set of identification labels comprising identification data associated with the dispensing apparatus and/or the reagents.

26. The dispensing apparatus according to claim 25, wherein the identification labels comprise a first identification label permanently disposed on the dispensing apparatus and comprising encoded first identification data associated with the dispensing apparatus.

27. The dispensing apparatus according to claim 26, wherein the identification labels comprise a second identification label permanently disposed on the dispensing apparatus and comprising encoded second identification data associated with reagents contained in the cuvettes.

28. The dispensing apparatus according to claim 27, wherein the identification labels comprise a third identification label detachably attached to the dispensing apparatus and comprising encoded third identification data for accessing assay results from an assay process performed on the biofluid samples.

29. The dispensing apparatus according to claim 27 or 28, wherein the first identification data and/or second identification data are verifiable against reference identification data for verifying the dispensing apparatus and/or the reagents.

30. The dispensing apparatus according to any one of claims 25 to 29, wherein each identification label comprises a matrix barcode.

31. A computer program comprising computer executable instructions that, when executed by a processor, cause the processor to control an additive manufacturing

~~apparatus to manufacture the dispensing apparatus according to any one of claims 1 to 30.~~

~~32. A method of manufacturing a product via additive manufacturing, the method comprising:~~

~~obtaining an electronic file representing a geometry of the product wherein the product is the dispensing apparatus according to any one of claims 1 to 30; and~~

~~controlling an additive manufacturing apparatus to manufacture, over one or more additive manufacturing steps, the product according to the geometry specified in the electronic file.~~

~~33~~11. An assay apparatus for assaying biofluid, the assay apparatus comprising:

a vacuum chamber for removably housing a dispensing apparatus comprising a set of cuvettes and a set of biofluid samples, the cuvettes comprising a set of reagents;

a vacuum cover for sealing the dispensing apparatus in the vacuum chamber;

a vacuum device for applying vacuum pressure in the vacuum chamber, the vacuum pressure for dispensing the biofluid samples into the cuvettes, such that the biofluid samples react with the reagents to form assay samples; and

a set of assay control systems for controlling the vacuum device and performing an assay process, the assay process comprising applying the vacuum pressure to dispense the biofluid samples and assaying the assay samples in the cuvettes.

~~34~~12. The assay apparatus according to claim ~~33~~11, wherein the vacuum chamber and the vacuum cover comprise a set of interlocking detectors for detecting that the vacuum cover is closed.

~~35. The assay apparatus according to claim 34, wherein the interlocking detectors comprise a magnetic element and a magnetic sensor.~~

36. The assay apparatus according to claim 34 or 35, wherein the vacuum cover comprises a photo-interrupter to detect that the vacuum cover is closed.

37. The assay apparatus according to any one of claims 33 to 36, wherein the vacuum cover comprises a vacuum cover handle for handling the vacuum cover.

38. The assay apparatus according to claim 37, wherein the vacuum cover handle is moveable between a closed state and an open state, wherein the vacuum cover is openable from the vacuum chamber when the vacuum cover handle is in the open state.

39. The assay apparatus according to claim 38, wherein the vacuum cover comprises a vacuum cover actuator engageable with the vacuum cover handle for locking the vacuum cover handle in the closed state.

40. The assay apparatus according to claim 38 or 39, wherein the vacuum cover handle has an intermediary state between the closed and open states, and wherein the vacuum cover unlocks while the vacuum cover handle moves from the intermediary state to the open state.

41. The assay apparatus according to any one of claims 38 to 40, wherein an optical measurement system of the assay apparatus is deactivated when the vacuum cover handle is in the open state.

42. The assay apparatus according to any one of claims 33 to 39, further comprising a set of valves fluidically connected to the vacuum device to facilitate application of the vacuum pressure.

43. The assay apparatus according to any one of claims 33 to 41, further comprising a carbon filter fluidically connected to the vacuum device for cleaning of air exchange between the vacuum device and the vacuum chamber.

4413. The assay apparatus according to ~~any one of~~ claim~~s 33~~ 11 or~~to 43~~12, further comprising a vacuum actuator actuatable by application of the vacuum pressure.

4514. The assay apparatus according to claim 4413, wherein the vacuum cover comprises a vacuum actuator housing for the vacuum actuator.

4615. The assay apparatus according to claim ~~44~~ 13 or 4514, wherein the vacuum actuator is actuatable to displace a piston assembly of the dispensing apparatus to thereby dispense the biofluid samples.

~~47. The assay apparatus according to any one of claims 44 to 46, wherein the vacuum actuator comprises a spring to bias the vacuum actuator to a disengaged position.~~

4816. The assay apparatus according to any one of claims ~~33~~ 11 to 4715, wherein the assay control systems comprise an electromagnetic mixing system for mixing the biofluid samples with the reagents in the cuvettes.

~~49. The assay apparatus according to claim 48, wherein the electromagnetic mixing system comprises a set of electromagnetic units for generating magnetic fields within the cuvettes.~~

~~50. The assay apparatus according to claim 49, wherein the magnetic fields cause movement of a magnetic object in each cuvette to facilitate said mixing.~~

~~51. The assay apparatus according to any one of claims 33 to 50, wherein the assay control systems comprise an optical measurement system for performing spectroscopy on the assay samples.~~

~~52. The assay apparatus according to claim 51, wherein the optical measurement system comprises at least one light source and at least one light detector.~~

53. The assay apparatus according to claim 52, wherein for each cuvette, a set of light source and light detector is arranged collinearly and paired with the cuvette.

54. The assay apparatus according to claim 52 or 53, wherein the optical measurement system comprises a number of baffles surrounding the light source and/or light detector to prevent light scattering.

55. The assay apparatus according to claim 52 or 53, further comprising a set of heat sinks, each light source disposed on a respective one of the heat sinks.

56. The assay apparatus according to any one of claims 52 to 55, wherein each light source comprises a light-emitting diode (LED) or laser diode.

57. The assay apparatus according to any one of claims 53 to 56, further comprising a set of optical elements arranged between the light source and light detector.

58. The assay apparatus according to claim 57, wherein the optical measurement system is configured to perform a calibration process to compensate for optical attenuation caused by the optical elements and the cuvettes.

59. The assay apparatus according to any one of claims 33 to 58, wherein the assay control systems comprise a temperature control system for monitoring and/or controlling temperature in the assay apparatus.

60. The assay apparatus according to claim 59, wherein the temperature control system comprises a set of heating and/or cooling units for heating and/or cooling the assay apparatus to within a predefined operating temperature range.

61. The assay apparatus according to any one of claims 33 to 60, wherein the assay control systems comprise a main control system for controlling the assay control systems and automating the assay process.

~~62. The assay apparatus according to claim 61, wherein the main control system is configured to provide feedback that the vacuum cover is a closed state.~~

~~63. The assay apparatus according to any one of claims 33 to 62, further comprising a connection interface for coupling to another assay apparatus.~~

~~64. The assay apparatus according to any one of claims 33 to 63, further comprising a set of reader devices for reading a set of identification labels disposed on the dispensing apparatus to thereby retrieve a set of identification data encoded in the identification labels.~~

~~65. The assay apparatus according to claim 64, wherein the assay apparatus is configured for receiving reference identification data for comparing with the set of identification data.~~

~~66. The assay apparatus according to claim 65, wherein the comparison enables verification of the dispensing apparatus and/or the reagents.~~

~~67~~17. A method for assaying biofluid, the method comprising:

providing an assay apparatus comprising a vacuum chamber, a vacuum cover, and a vacuum device;

loading a dispensing apparatus into the vacuum chamber, the dispensing apparatus comprising a set of cuvettes and a set of biofluid samples, the cuvettes comprising a set of reagents;

sealing the dispensing apparatus in the vacuum chamber with the vacuum cover;

operating the vacuum device to apply vacuum pressure in the vacuum chamber, the vacuum pressure for dispensing the biofluid samples into the cuvettes, such that the biofluid samples react with the reagents to form assay samples; and

operating a set of assay control systems to control the vacuum device and perform an assay process, the assay process comprising applying the

vacuum pressure to dispense the biofluid samples and assaying the assay samples in the cuvettes.

~~68. The method according to claim 67, wherein the assay process comprises actuating a vacuum actuator by application of the vacuum pressure.~~

~~69. The method according to claim 68, wherein the assay process comprises displacing, by actuation of the vacuum actuator, a piston assembly of the dispensing apparatus to thereby dispense the biofluid samples.~~

~~70. The method according to any one of claims 67 to 69, wherein the assay control systems comprise an electromagnetic mixing system, the assay process comprising mixing, using the electromagnetic mixing system, the biofluid samples with the reagents in the cuvettes.~~

~~71. The method according to any one of claims 67 to 70, wherein the assay control systems comprise an optical measurement system, the assay process comprising performing spectroscopy on the assay samples using the optical measurement system.~~

~~72. The method according to claim 71, wherein the assay process comprises performing, using the optical measurement system, a calibration process to compensate for optical attenuation caused by the cuvettes and optical elements of the optical measurement system.~~

~~73. The method according to any one of claims 67 to 72, wherein the assay control systems comprise a temperature control system, the assay process comprising monitoring and/or controlling temperature in the assay apparatus using the temperature control system.~~

~~74. The method according to any one of claims 67 to 73, wherein the assay control systems comprise a main control system for controlling the assay control systems and automating the assay process.~~

~~75. The method according to any one of claims 67 to 74, wherein the assay apparatus comprises a set of reader devices, the method further comprising:~~

~~reading, using the reader devices, a set of identification labels disposed on the dispensing apparatus; and~~

~~retrieving a set of identification data encoded in the identification labels.~~

~~76. The method according to claim 75, further comprising receiving reference identification data from a pre-established database.~~

~~77. The method according to claim 76, further comprising comparing the set of identification data against the reference identification data for verification of the dispensing apparatus and/or the reagents.~~

~~78~~18. An assay system for assaying biofluid, the assay system comprising:

a base station;

a number of test stations communicatively connected to the base station, each test station comprising an assay apparatus, the assay apparatus comprising:

a vacuum chamber for removably housing a dispensing apparatus comprising a set of cuvettes and a set of biofluid samples, the cuvettes comprising a set of reagents;

a vacuum cover for sealing the dispensing apparatus in the vacuum chamber; and

a set of assay control systems for performing an assay process; and

the assay system further comprising a set of vacuum devices for applying vacuum pressure in the vacuum chambers of the test stations, the vacuum pressure for dispensing the biofluid samples into the cuvettes, such that the biofluid samples react with the reagents to form assay samples,

wherein the respective assay process comprises applying the vacuum pressure to dispense the biofluid samples and assaying the assay samples in the cuvettes; and

wherein the base station is configured for controlling the test stations to perform the assay processes.

~~79. The assay system according to claim 78, wherein the base station is integrated with one of the test stations.~~

~~80. The assay system according to claim 78 or 79, wherein the assay apparatus of each test station comprises a respective one of the vacuum devices, the respective vacuum device configured for applying vacuum pressure in the vacuum chamber of the respective test station.~~

~~81. The assay system according to claim 78 or 79, comprising a common vacuum device fluidically connected to the vacuum chambers of all the test stations, wherein the common vacuum device is configured for applying vacuum pressure in all the vacuum chambers.~~

~~82. The assay system according to any one of claims 78 to 81, wherein the test stations are physically connected to the base station in a series arrangement.~~

~~83. The assay system according to claim 82, wherein the base station and the test stations are integrally connected to each other in a monolithic arrangement.~~

~~84~~19. The assay system according to ~~any one of~~ claim~~s 78 to 83~~18, wherein for each test station, the base station is configured to:

transmit a respective set of instructions to the test station to perform the respective assay process; and/or

transmit a common set of instructions to all the test stations to simultaneously perform the assay processes.

~~85. The assay system according to claim 80, wherein the vacuum pressures applied in the respective vacuum chambers are substantially equal to each other.~~

~~86. The assay system according to claim 80, wherein the vacuum pressures applied in the respective vacuum chambers different from each other.~~

~~87. The assay system according to any one of claims 78 to 86, wherein the base station comprises a communications device for transmitting instructions to the test stations to perform the assay processes.~~

~~88. An identification system for supporting an assay process performed on biofluid samples of a patient, the identification system comprising:~~

~~a first identification label permanently disposed on a dispensing apparatus for collecting and dispensing biofluid for assaying, the first identification label comprising encoded first identification data associated with the dispensing apparatus;~~

~~a second identification label permanently disposed on the dispensing apparatus, the second identification label comprising encoded second identification data associated with reagents contained in cuvettes of the dispensing apparatus; and~~

~~a third identification label detachably attached to the dispensing apparatus, the third identification label comprising encoded third identification data for the patient to access the assay results,~~

~~wherein the first identification data and/or second identification data are verifiable against reference identification data for verifying the dispensing apparatus and/or the reagents; and~~

~~wherein the third identification data enable the patient to access the assay results using an electronic device of the patient.~~

~~89. The identification system according to claim 88, wherein each identification label comprises a matrix barcode.~~

~~90~~20. A computerized method for availing assay results from an assay process performed on biofluid samples of a patient, the computerized method comprising:

receiving, from a first electronic device, a request from the patient to access an online interface and initiate the assay process, the patient request

comprising a device identifier of the first electronic device and identification data associated with a dispensing apparatus for collecting the biofluid samples;

associating the identification data with the device identifier;

receiving, from a second electronic device, a request from an operator performing the assay process to access the online interface and input the assay results, the operator request comprising the identification data and the assay results;

associating the assay results with the identification data; and

sending a results message to the first electronic device, the results message indicating the assay results are available on the online interface accessed by the first electronic device.

~~91. The computerized method according to claim 90, further comprising deactivating the identification data in response to the first electronic device accessing the assay results on the online interface.~~

~~92. The computerized method according to claim 89 or 90, further comprising:~~

~~starting a predefined waiting period for the identification data in response to receiving the patient request; and~~

~~deactivating the identification data if the assay results are not received after the predefined waiting period has lapsed.~~

~~93. The computerized method according to claim 92, further comprising sending, to the first electronic device, a waiting message in response to starting of the predefined waiting period.~~

~~94. The computerized method according to any one of claims 90 to 93, further comprising deactivating the third identification data if the assay results are not accessed after a predefined expiry period has lapsed.~~

~~95. The computerized method according to any one of claims 90 to 94, further comprising verifying the identification data against reference identification data.~~