CLAIMS

~~What is claimed is:~~

1. A microfluidic device for handling a fluid sample~~, the microfluidic device~~ comprising:

at least one microfluidic well configured to receive the fluid sample, at the at least one microfluidic well ~~including a plurality of microchambers and at least one~~ comprising

a primary inlet fluidly coupled to an inlet microfluidic channel,

the inlet microfluidic channel fluidly ~~coupling the plurality of microchambers;~~ coupled to a plurality of parallel microfluidic channels at inlet ends of the parallel microfluidic channels, each microfluidic channel comprising a plurality of microchambers arranged in series that are fluidly coupled, via an outlet end, to an outlet microfluidic channel,

the outlet microfluidic channel fluidly coupled to a primary vent configured to vent gas from the parallel microfluidic channels,

wherein each microchamber ~~including~~ comprises a reaction chamber ~~and a vent chamber, the reaction chamber~~ configured to receive the fluid sample ~~from the microfluidic channel~~ and ~~the~~ a vent chamber configured to vent gas from the reaction chamber ~~via the microfluidic channel~~ as the fluid sample flows into the reaction chamber,

wherein the reaction chamber is fluidly coupled to a corresponding microfluidic channel via an inlet and the vent chamber is fluidly coupled to said corresponding microfluidic channel via an outlet,

wherein the reaction chamber is configured to flow the fluid sample to the vent chamber after the gas has been vented to outlet.

~~2. The microfluidic device according to claim 1, wherein the reaction chamber is fluidly coupled to a first segment of the microfluidic channel and the vent chamber is fluidly coupled to a second segment of the microfluidic channel.~~

~~3. The microfluidic device according to claim 2, wherein the first segment of the microfluidic channel fluidly couples the reaction chamber to a first microchamber located adjacent to the reaction chamber.~~

~~4. The microfluidic device according to claim 3, wherein the second segment of the microfluidic channel fluidly couples the vent chamber to a second microchamber located adjacent to the vent chamber.~~

~~5~~2. The microfluidic device according to claim 1, wherein the reaction chamber is larger than the vent chamber.

~~6. The microfluidic device according to claim 1, wherein the reaction chamber is fluidly coupled to the vent chamber.~~

~~7~~3. The microfluidic device according to claim 1, wherein the vent chamber is configured with a narrow hydrophobic stricture to initially prevent flow of the fluid sample from the reaction chamber while allowing flow of gas from the reaction chamber as the fluid sample flows into the reaction chamber.

~~8~~4. The microfluidic device according to claim ~~7~~3, wherein the vent chamber is configured to release flow of the fluid sample from the reaction chamber when the gas has been vented from the reaction chamber.

~~9. The microfluidic device according to claim 1, wherein the vent chamber includes an entrance configured to act as a valve.~~

~~10. The microfluidic device according to claim 1, wherein the at least one microfluidic well includes a plurality of microfluidic channels, each microfluidic channel fluidly couples a group of microchambers.~~

~~11. The microfluidic device according to claim 10, wherein each microfluidic channel fluidly couples the group of microchambers in series.~~

~~12. The microfluidic device according to claim 1, wherein each microfluidic channel includes an inlet end and an outlet end, the at least one microfluidic well including an inlet channel and an outlet channel, each inlet end being fluidly coupled to the inlet channel and each outlet end being fluidly coupled to the outlet channel.~~

~~13. The microfluidic device according to claim 12, wherein the at least one microfluidic well includes a main inlet configured to receive the fluid sample, the main inlet fluidly coupled to the inlet channel.~~

~~14. The microfluidic device according to claim 13, wherein the at least one microfluidic well includes a main vent configured to vent gas from the plurality of microchambers, the main vent fluidly coupled to the outlet channel.~~

~~15~~5. The microfluidic device according to claim 1, wherein the reaction chamber has a diameter D and the vent chamber has a length L extending in a direction along the ~~microchannel~~ plurality of microfluidic channels arranged in parallel and a width W extending in a direction perpendicular to the length,

wherein the vent chamber ~~configured to have~~ has a diameter-to-width ratio based on the diameter (D) of the reaction chamber compared to the width (W) of the vent chamber of $D/W \geq 2$ and length-to-width ratio based on the length (L) and width (W) of the vent chamber of $L/W \geq 0.7$.

~~16~~6. The microfluidic device according to claim ~~15~~5, the vent chamber has a length-to-width ratio of $L/W \geq 0.8$.

~~17~~7. The microfluidic device according to claim ~~16~~6, the vent chamber has a length-to-width ratio of $L/W \geq 0.9$.

~~18~~8. The microfluidic device according to claim ~~17~~7, the vent chamber has a length-to-width ratio of $L/W \geq 1$.

9. The microfluidic device according to claim 5, wherein the reaction chamber has a diameter $D \leq 600$ µm.

~~19. The microfluidic device according to claim 15, wherein the reaction chamber has a depth d and a depth-to-diameter ratio of $d/D \leq 2$.~~

~~20~~10. The microfluidic device according to claim ~~19~~9, wherein the reaction chamber has a depth-to-diameter ratio d/D of about 1.5.

~~21. The microfluidic device according to claim 15, wherein the reaction chamber has a diameter D ≤ 600 μm.~~

~~22~~11. The microfluidic device according to claim ~~21~~9, wherein the reaction chamber has a diameter D of at least 60 μm.

~~23~~12. The microfluidic device according to claim 1, wherein ~~the~~ each reaction chamber has a depth d and ~~the~~ each microfluidic channel comprising a plurality of microchambers has segments connecting the plurality of microchambers, wherein the segments has~~ve~~ a depth d_2, a ratio d/d_2 of the reaction chamber depth to the microfluidic channel segment depth being no more than 2:1.

~~24~~13. The microfluidic device according to claim ~~23~~12, wherein the vent chamber has a depth which is at least 50% of the reaction chamber depth.

~~25. A microfluidic device for handling a fluid sample, the microfluidic device comprising:~~

~~at least one microfluidic well configured to receive the fluid sample; and~~

~~a microfluidic circuit provided in the at least one microfluidic well, the microfluidic circuit configured to distribute the fluid sample within the microfluidic well;~~

~~the microfluidic circuit including a plurality of reaction chambers, at least one microfluidic channel fluidly coupling the reaction chambers, and a plurality of microfluidic valves associated with the plurality of reaction chambers, each microfluidic valve being fluidly coupled to an associated reaction chamber;~~

~~each reaction chamber configured to receive a fluid sample from the microfluidic channel and each microfluidic valve configured to vent gas from a corresponding reaction chamber via the microfluidic channel as the fluid sample flows into the reaction chamber.~~

~~26. The microfluidic device according to claim 25, wherein the reaction chamber is arranged in the microfluidic circuit to receive fluid from an upstream segment of the microfluidic channel and the microfluidic valve is arranged in the microfluidic circuit to deliver fluid to a downstream segment of the microfluidic channel.~~

27. The microfluidic device according to claim 25, wherein the plurality of reaction chambers includes first and second reaction chambers, one of the microfluidic valves being located between the first and second reaction chambers.

28. The microfluidic device according to claim 27, wherein the first reaction chamber is fluidly coupled to the microfluidic valve and the microfluidic valve is fluidly coupled to the second reaction chamber, the microfluidic circuit being arranged to direct the fluid sample to flow from the first reaction chamber through the microfluidic valve to the second reaction chamber.

29. The microfluidic device according to claim 28, wherein the microfluidic valve is configured to restrict the flow of the fluid sample from the first reaction chamber until a predefined volume of the fluid sample has been received in the first reaction chamber.

30. The microfluidic device according to claim 25, wherein each microfluidic valve is configured to be a passive valve.

31. The microfluidic device according to claim 25, wherein each microfluidic valve is formed of a hydrophobic material.

32. The microfluidic device according to claim 31, wherein each microfluidic valve is formed from one or more of polypropylene, polyethylene and PTFE.

33. A method of handling a fluid sample, the method comprising acts of:

(a) delivering a fluid sample to a microfluidic device including a plurality of microchambers and at least one microfluidic channel fluidly coupling the plurality of microchambers, each microchamber including a reaction chamber and a vent chamber fluidly coupled to the reaction chamber;

(b) directing the fluid sample into the reaction chamber of each microchamber; and

(c) venting gas from the reaction chamber via the vent chamber as the fluid sample flows into the reaction chamber.

34. The method according to claim 33, wherein act (b) includes directing the fluid sample into the reaction chamber through a first segment of the microfluidic channel and act (c) includes venting gas through a second segment of the microfluidic channel.

~~35. The method according to claim 34, wherein act (c) includes directing the fluid sample to flow from the vent chamber to the second segment of the microfluidic channel.~~

~~36. The method according to claim 33, further comprising act (d) of preventing the fluid sample from flowing into the vent chamber during act (c).~~

~~37. The method according to claim 36, further comprising act (e) of releasing the fluid sample from the reaction chamber into the vent chamber when the gas has been vented from the reaction chamber.~~

~~38. The method according to claim 33, wherein the plurality of microchambers includes first, second and third microchambers fluidly coupled by the at least one microfluidic channel, a first segment of the microfluidic channel fluidly coupling the first and second microchambers and a second segment of the microfluidic channel fluidly coupling the second and third microchambers.~~

~~39. The method according to claim 33, further comprising act (f) of performing digital PCR on the microfluidic device after filling the reaction chambers with the fluid sample.~~