semi-conductor fabrication techniques which do not require any "exotic" processes or materials. Of course, a certain degree of trade off will be undertaken in that if the advantages of using the exotic material far out weighs its disadvantages then it may become desirable to utilize the material anyway. However, if it is possible to achieve the same, or similar, properties using more common materials, the problems of exotic materials can be avoided.

A desirable characteristic of inkjet printheads would be a hydrophobic ink ejection face ("front face" or "nozzle face"), preferably in combination with hydrophilic nozzle chambers and ink supply channels. Hydrophilic nozzle chambers and ink supply channels provide a capillary action and are therefore optimal for priming and for re-supply of ink to nozzle chambers after each drop ejection. A hydrophobic front face minimizes the propensity for ink to flood across the front face of the printhead. With a hydrophobic front face, the aqueous inkjet ink is less likely to flood sideways out of the nozzle openings. Furthermore, any ink which does flood from nozzle openings is less likely to spread across the face and mix on the front face – they will instead form discrete spherical microdroplets which can be managed more easily by suitable maintenance operations.

Hitherto, the present Applicant has described the use of PDMS (polydimethylsiloxane) for coating the front face of a printhead and providing a hydrophobic surface. However, whilst PDMS has excellent hydrophobic properties and can be readily incorporated into a printhead MEMS fabrication process, it has relatively poor wear-resistance and may be scratched or otherwise damaged by a wiper blade used for printhead maintenance (see, for example, US Application No. 12/014,772, filed on January 16, 2008 incorporated herein by reference). It would therefore be desirable to provide a printhead having a hydrophobic ink ejection face, which can be readily produced by a MEMS fabrication process and which has good wear-resistance.

Summary of the Invention

According to an aspect of the present invention, there is provided a printhead comprising a plurality of nozzle assemblies formed on a substrate, each nozzle assembly comprising: a nozzle chamber, a nozzle opening defined in a roof of the nozzle chamber; and a thermal bend actuator defining a moving portion of the roof of each nozzle chamber, said thermal bend actuator comprising: a first active element for connection to drive circuitry; and a second passive element mechanically cooperating with the first element, such that when a current is passed through the first element, the first element expands relative to the second element, resulting in bending of the actuator towards a floor of said nozzle chamber, wherein a hydrophobic polymeric material is coated on a nozzle plate of the printhead, said nozzle plate being at least partially defined by the roof of each nozzle chamber, and wherein the hydrophobic polymeric material is selected from the group consisting of: polysilsesquioxanes.

In a first embodimentaspect, there is provided a printhead having an ink ejection face, wherein at least part of the ink ejection face is coated with a hydrophobic polymeric material, the polymeric material being comprised of a polysilsesquioxane. Printheads according to embodiments of the present invention have excellent durability and wear-resistance making them compatible with various printhead maintenance operation involving contact with the ink ejection face (e.g. wiping). Moreover, the polysilsesquioxane can be deposited in a thin layer (0.5 to 2

Optionally, nozzle opening is defined in a stationary portion of the roof.

Optionally, the polymeric material defines a mechanical seal between the moving portion and a stationary portion of the roof, thereby minimizing ink leakage during actuation of the actuator.

In a second embodiment~~aspect~~, there is provided a printhead having an ink ejection face, wherein at least part of the ink ejection face is coated with a polymeric material, said polymeric material being comprised of a polymerized siloxane incorporating nanoparticles. In accordance with the second embodiment~~aspect~~, the nanoparticles impart desirable properties to the polymeric coating, such as durability, wear-resistance, fatigue-resistance, hydrophobicity, hydrophilicity etc.

Optionally, the polymerized siloxane is selected from the group consisting of: poly(alkylsilsesquioxanes), poly(arylsilsesquioxanes) and polydialkylsiloxanes

Optionally, the polymerized siloxane is selected from the group consisting of: poly(methylsilsesquioxane), poly(phenylsilsesquioxane) and polydimethylsiloxane.

Optionally, the nanoparticles are selected from the group consisting of: inorganic nanoparticles and organic nanoparticles.

Optionally, the inorganic nanoparticles are selected from the group consisting of: metal oxides, metal carbonates and metal sulfates.

Optionally, the inorganic nanoparticles are selected from the group consisting of: silica, zirconium oxide, titanium oxide, aluminium oxide, calcium carbonate, tin oxide, zinc oxide, copper oxide, chromium oxide, calcium oxide, tungsten oxide, iron oxide, cobalt oxide and barium sulfate.

Optionally, the organic nanoparticles are selected from the group consisting of: cross-linked silicone resin particles, cross-linked polyolefin resin particles, cross-linked acryl resin particles, cross-linked styrene-acryl resin particles, cross-linked polyester particles, polyimide particles, melamine resin particles and carbon nanotubes.

Optionally, the nanoparticles are incorporated in the polymerized siloxane in an amount ranging from 1 to 70 wt.%.

Optionally, the nanoparticles have an average particle size in the range of 1 to 100nm.

Optionally, the printhead compriss a plurality of nozzle assemblies formed on a substrate, each nozzle assembly comprising: a nozzle chamber, a nozzle opening defined in a roof of the nozzle chamber and an actuator for ejecting ink through the nozzle opening.

Optionally, the polymeric material is coated on a nozzle plate of the printhead, the nozzle plate being at least partially defined by the roof of each nozzle chamber.

Optionally, each nozzle chamber comprises a roof and sidewalls comprised of a ceramic material selected from the group consisting of: silicon nitride, silicon oxide and silicon oxynitride.

Optionally, the roof is spaced apart from the substrate, such that sidewalls of each nozzle chamber extend between the nozzle plate and the substrate.

Optionally, the actuator is a heater element configured for heating ink in the chamber so as to form a gas bubble, thereby forcing a droplet of ink through the nozzle opening.

Optionally, the heater element is suspended in the nozzle chamber.

Optionally, the actuator is a thermal bend actuator comprising:

a first active element for connection to drive circuitry; and

a second passive element mechanically cooperating with the first element, such that when a current is passed through the first element, the first element expands relative to the second element, resulting in bending of the actuator.

Optionally, the thermal bend actuator defines at least part of a roof of each nozzle chamber, whereby actuation of said actuator moves said a moving portion of said roof towards a floor of said nozzle chamber.

Optionally, the nozzle opening is defined in either one of: said moving portion of said roof; or a stationary portion of said roof.

Optionally, the polymeric material defines a mechanical seal between said moving portion and a stationary portion of said roof, thereby minimizing ink leakage during actuation of said actuator.

In a third embodimentaspect, there is provided an inkjet printhead for ejection of an ejectable fluid, the printhead having an ink ejection face coated with a polymeric material incorporating nanoparticles, wherein the nanoparticles impart one or more predetermined characteristics to the ink ejection face, the predetermined characteristics complementing at least one of:

an inherent property of the ejectable fluid;

a printhead maintenance regime associated with the printhead; and

a type of nozzle actuator.

The invention according to the third embodimentaspect enables the surface characteristics of the ink ejection face to be tuned to a predetermined characteristic of the printer. For

example, printhead maintenance may be prioritized in some printers, whereas optimal fluid ejection may be prioritized in other printers. Alternatively, the nanoparticles may be selected to provide a compromise of printer characteristics.

Optionally, the one or more predetermined characteristics are selected from the group consisting of: hydrophilicity; hydrophobicity; wear-resistance; and fatigue-resistance.

Optionally, the one or more predetermined characteristics are imparted by one or more of: surface energy characteristics of the nanoparticles; size of the nanoparticles; amount of the nanoparticles; and wearability of the nanoparticles.

Optionally, the nanoparticles are selected from the group consisting of: inorganic nanoparticles and organic nanoparticles.

Optionally, the inorganic nanoparticles are selected from the group consisting of: silica, zirconium oxide, titanium oxide, aluminium oxide, calcium carbonate, tin oxide, zinc oxide, copper oxide, chromium oxide, calcium oxide, tungsten oxide, iron oxide, cobalt oxide and barium sulfate.

Optionally, the organic nanoparticles are selected from the group consisting of: cross-linked silicone resin particles, cross-linked polyolefin resin particles, cross-linked acryl resin particles, cross-linked styrene-acryl resin particles, cross-linked polyester particles, polyimide particles, melamine resin particles and carbon nanotubes.

Optionally, the the inherent property of the ejectable fluid is selected from the group consisting of: hydrophilicity; hydrophobicity; viscosity; surface tension; and boiling point.

Optionally, the ejectable fluid is selected from the group consisting of: aqueous fluids and non-aqueous fluids.

Optionally, the printhead maintenance regime comprises one or more operations selected from the group consisting of: printhead capping; printhead wiping; printhead flooding; and non-contact ink removal.

Optionally, the the polymeric material is a comprised of a polymerized siloxane.

Optionally, the polymerized siloxane is selected from the group consisting of: poly(alkylsilsesquioxanes), poly(arylsilsesquioxanes) and polydialkylsiloxanes

Optionally, the polymerized siloxane is selected from the group consisting of: poly(methylsilsesquioxane), poly(phenylsilsesquioxane) and polydimethylsiloxane.

Other optional featureembodiments of the printhead according to the third embodimentaspect mirror those optional featureembodiments according to the first and second embodimentaspects.