The wafer thickness is preferably in the range of 350 to 600 μm, depending on the desired structure. Ohmic contacts are made by using phosphorous ion implantation into regions in the backside, preferably to a depth of 0.2 to 5 μm. Alternatively, a p-type silicon wafer may be used, and the ohmic contacts made using boron ion implantation. Implantation is followed by heating of the substrate to activate the dopant.

[0188] Next, the fluid ports **28** and **30** are formed by depositing and patterning a suitable masking material, e.g., silicon nitride, onto the backside of the wafer and anisotropic etching the silicon using the mask. The wafer is then patterned with photoresist on the frontside to obtain an etch mask for the DRIE process. As shown in FIG. **11**, the etch mask defines a chamber pattern **44** for forming the extraction chamber in the substrate **22** and an array of column patterns **46** for forming a corresponding array of columns in the substrate. The patterned wafer is then etched using a DRIE process to form the extraction chamber and integral columns. The wafer is etched to a depth sufficient for the extraction chamber **26** to meet the fluid ports **28** and **30**.

[0189] After etching, the remaining photoresist is removed from the wafer, and the substrate is then oxidized to cover the internal surfaces of the chamber **26** with an oxide layer, preferably 1 to 100 nm thick. An electrically conductive material, e.g., aluminum, gold, or copper, is then deposited and patterned over the doped regions on the backside of the substrate to form the electrodes **48**A and **48**B. The substrate **22** is then anodically bonded to a cover **24**, preferably thin Pyrex™ glass. After bonding, the substrate pair may be diced to form the final structure shown in FIG. **12**.

[0190] FIG. **13** shows a flow-through chip **21** according to another embodiment of the invention in which the internal attachment surfaces for capturing and eluting the analyte are formed by one or more solid supports contained within the chamber **26**. As the fluid sample flows through the chamber **26**, the analyte contacts and adheres to the solid support. To elute the analyte, the chamber **26** is heated while an elution fluid is forced to flow through the chamber, thus releasing the analyte from the solid support into the elution fluid. Suitable solid supports for capturing the analyte include filters, beads, fibers, membranes, glass wool, filter paper, gels, etc.

[0191] In the embodiment of FIG. **13**, the solid support comprises glass beads **50** packed within the chamber **26**. In embodiments that employ beads, fibers, wool, or gels as the solid support, the device preferably includes a barrier **52** disposed in the chamber **26** adjacent the outlet port **30** for preventing the solid support material from flowing out of the chamber. The barrier **52** may be any suitable retaining membrane or filter, such as a comb filter, for holding the solid support material within the chamber **26**. Alternatively, the barrier **52** may comprise a plurality of internal structures, such as columns, formed within the chamber **26** and having a sufficiently small spacing to retain the solid support material.

[0192] The chip **21** may be used in combination with the cartridges of the invention to capture and elute target analyte, as previously described. The operation of the chip **21** is analogous to the operation described above, except that the analyte capture surfaces in the chamber **26** are provided by a solid support, such as the beads **50**, rather than by an array of integrally formed microstructures.

[0193] The chip **21** may be fabricated using techniques similar to those described in earlier embodiments, including photolithography and micromachining. A preferred method for fabricating the chip will now be described. A 100 mm, n-type (100), 0.1 to 0.2 ohm-cm, silicon wafer is preferably used as starting material for the base substrate **22**. The wafer is patterned with photoresist on the frontside to obtain an etch mask for a DRIE process. The etch mask defines a chamber pattern for forming the chamber **26** in the substrate **22** and a barrier pattern for forming internal barrier structures, preferably closely spaced columns, within the chamber **26**. The patterned wafer is then etched using a DRIE process to form the chamber **26** and internal barrier structures. Of course, the structures should have a spacing smaller than the diameter of the beads **50** so that they will retain the beads in the chamber **26**.

[0194] After etching, the remaining photoresist is removed from the wafer, and one or more electrically conductive materials is then deposited and patterned on the backside of the substrate to form a, resistive heating element, temperature sensor, and bond pads.

[0195] The substrate is then anodically bonded to a glass cover having holes that form the fluid ports **28** and **30**. The beads **50** may be packed in the chamber **26** before or after attaching the cover, preferably after the cover is attached. The beads **50** are inserted through the inlet port **28**. Of course, the barrier **52** should be in place before packing the beads **50** to prevent the beads from flowing out of the chamber **26**.

[0196] FIG. **14** shows a flow-through chip **31** according to another embodiment of the invention in which the solid support contained within the chamber **26** comprises a membrane or filter **60** for capturing the target analyte. The chip **31** includes a base substrate **58**, a top substrate **54**, and a middle substrate **56** sandwiched between the top and base substrates. The extraction chamber **26** is formed in the top and base substrates **54** and **58**, and the filter **60** is preferably in thermal contact with the heater **34**. Alternatively, the filter **60** may be disposed in the base substrate **58** adjacent the outlet port **30**.

[0197] The resistive heating element **34** is preferably positioned on the middle substrate **56** for heating the chamber **26**. The heating element **34** may be covered by a layer **62** of insulating material, e.g., silicon dioxide, silicon carbide, silicon nitride, plastic, glass, glue or other polymers, resist, or ceramic, for protecting the heating element **34** from fluids flowing through the chamber **26**. The middle substrate **56** includes holes (not shown in the side view of FIG. **14**) disposed around the heating element **34** to permit continuous fluid flow through the chamber from the inlet port **28** to the outlet port **30**.

[0198] The heating element **34** may be a thin film of metal or polysilicon which is patterned on the substrate **56**. Alternatively, the substrate **56** may be a thin plastic flex-circuit having the heating element **34**. In another embodiment, the heating element **34** may comprise a laminated heater source, such as an etched foil-heating element, attached to the substrate **56**. In embodiments where the heater is part of a laminated structure, the substrate **56** is the support for the heater. In yet another embodiment, the substrates **56** and **58**, together with the heating element **34** and insulator layer **62**, may all be fabricated from a single substrate using techniques known to those skilled in the art, e.g., thin film processing.

[0199] The chip **31** is used in combination with a cartridge of the present invention, as previously described. In operation, a fluid sample is forced to flow through the chip. As the fluid sample flows through the chamber **26**, target analyte, e.g., nucleic acid, contacts and adheres to the filter **60**. The chamber is optionally washed to remove unwanted particles. To elute the analyte, the chamber **26** is heated with the heating