as well as to set forth the best modes contemplated for carrying out various aspects of the invention. It is understood that these examples in no way serve to limit the true scope of this invention, but rather are presented for illustrative purposes. All references cited herein are incorporated by reference.

EXAMPLES

Example 1

Fabrication Example for 50 μm High Ridge Structures Compression Molded Into Polycarbonate Structures Using an Etched Silicon Stamper

[0330] Silicon Stamper Fabrication

[0331] A plastic replication technique was implemented to construct ridge microstructures inside plastic microchannels. The polycarbonate microchannels were fabricated by compression molding using Carver hydraulic laboratory presses (Carver, Inc., Wabash, Ind.). Silicon (Si) stamper was used as a mold to transfer the channel/ridge patterns into the plastic. The Si stamper was fabricated using standard photolithographic procedures followed by a KOH anisotropic etching process. **FIG. 8** shows a schematic of the anisotropic etched Si structure. Note that the pyramidal grooves are transformed into ridge microstructures in the plastic chip after the plastic compression molding. Si is a crystal substrate that has different crystal planes. KOH (alkali hydroxide) is an anisotropic etchant that etches much faster at (100) and (110) planes than at (111) plane, resulting in pyramidal grooves, such as groove **900**, with 54.74° (111) sidewall angles (angle **910**) relative to the surface in the Si substrate.

[0332] During the KOH etching, a 1 μm thick protective coating (mask for KOH etching) of Si_3N_4 was first deposited on a silicon (100) wafer using low-pressure chemical vapor deposition (LPCVD). A 500 Å film of chromium was then deposited using a sputtering system at 300 watts and a pressure of 10 mtorr using argon at a flow rate of 50 sccm for 3 minutes. On the top side of the wafer, the chromium was patterned using a chromium etchant (CEN-300, Microchrome Technology Inc, San Jose, Calif.) for 1.5 minutes, and the $Si_3N_4$was etched by reactive ion etching (RIE) at 150 watts and a pressure of 50 mtorr using CF_4 at a flow rate of 50 sccm for 15 minutes. The Si wafer was then etched in a bath with 22.5% concentration of KOH at 75° C. for 35 min. The resulting channel is 1 mm wide and 50 μm deep. The pyramidal grooves are 50 μm wide and 50 μm deep (see **FIGS. 9 and 10**). **FIGS. 9 and 10** are scanning electron microscope (SEM) images of the anisotropic etched Si structure used to mold the plastic substrate.

[0333] Compression Molding

[0334] Following the etching of the Si stamper, the stamper was used as a mold to fabricate plastic microchannels with ridge microstructures. During the compression molding, a 5-mm-thick glass wafer was placed on the lower platen to provide a flat, smooth foundation surface. A 5-cm separation was established between the upper and lower platens. The silicon stamper was then placed on the glass wafer. The system was heated to 188° C. A predetermined amount of polycarbonate pellets (Aldrich) was placed in the center of the silicon stamper, and a blank nickel wafer was then placed on top of the polycarbonate pellets. The upper platen was lowered into contact with the blank nickel wafer and was then gradually compressed against the polycarbonate pellets as they melted. When the formed polycarbonate layer reached 1 mm in thickness, the two hot plates were separated, and the polycarbonate wafer and silicon stamper assembly were removed from the hydraulic press to air cool for ninety seconds. After cooling, the molded chip was demolded from the silicon stamper and the blank nickel plate. The entire molding process took approximately three minutes. The plastic microchannel with ridge microstructures is shown in **FIGS. 11 and 12**, which represent SEM images of the compression-molded plastic microchannel with ridge microstructures.

[0335] Electroplating

[0336] The molded structure was first sputtered with a metal seed layer of 100 angstroms Titanium-tungsten followed by 1000 angstroms of gold. The initial 100 angstroms of Ti—W is critical for adhesion to polymer substrates. A mask was used such that only the areas to be electroplated were sputtered. Following deposition of the seed layer, 80% nickel 20% iron alloy electroplating was performed with the following parameters: 1) Electroplating solution composition-200 g/L nickel chloride, 4 g/L ferrous chloride, 25 g/L boric acid, 1 g/L saccharin, 0.4 g/L sodium lauryl sulfate; 2) Operating conditions-pH 3, temperature 30 C, current density 2 A dm^{-2}

[0337] Time of deposition will depend on desired layer thickness. For a 50 μm thick layer, plating duration was about 2 hours.

[0338] For the structure detailed above, calculations show gradient strength in the vertical direction at the tips of the ridges was on the order of >10,000 T/m in an external magnetizing field of 0.3 T. This gradient falls off however to near 0 just 50 μm from the tips.

[0339] For deeper channels it will be desirable in high flow applications to fabricate larger saw-toothed features beneath and perpendicular to the original smaller ridges, typically about 0.5 to 1 mm apart. Grooves are cut in the substrate using a CO_2 engraving or excimer laser. Substrate material is ablated away until the original plating is exposed. Typical grooves are 300 μm wide at the base and 50 μm wide at the tip. The new grooves are then plated as before but with a longer plating time (>8 hrs) such that the grooves fill in and become solid. In this way it is possible to maintain useful separation gradients on the order of ~500 T/m at the far end of a 250 μm deep channel for the example given.

[0340] Once plating is complete the channel can be integrated with other components or used separately for direct detection. Depending on application, the channel is bonded to a top section comprising the substrate or microscope cover glass (for applications requiring viewing of the captured elements) or another magnetic channel.

Example 2

Fabrication of Microchannels With Dome Microstructures

[0341] A plastic replication technique was also implemented to construct micro-dome structures inside plastic microchannels. The polycarbonate microchannels were fab-