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Title: MOLDED KEY CAPS AND METHODS OF MAKING

Abstract: In certain embodiments, a method of manufacturing a key pad includes forming a plurality of upper key portions comprising a first material that has a first hardness, and forming a plurality of lower key portions comprising a second material that has a second hardness lower than the first hardness. Each of a plurality of keys includes one of the plurality of lower key portions and one of the plurality of upper key portions, and a plurality of such keys are attached to a flexible connecting member to form a key pad. In further embodiments, a key pad can include a plurality of key caps comprising a top comprising a first material and a key bottom comprising a second material. The key bottom is coupled to the key top, and the first material has a first hardness, and the second material has a second hardness lower than the first hardness. The key pad further includes a flexible connecting member coupled to the key bottom of the plurality of key caps.

FIG. 1B
MOLDED KEY CAPS AND METHODS OF MAKING

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 61/186,155, filed June 11, 2009, the entirety of which is hereby incorporated by reference.

BACKGROUND

Field of the Invention

[0002] Embodiments of the present disclosure relate to molded key caps and methods of making molded key caps. Further embodiments relate to key caps that include at least two different materials.

Description of the Related Art

[0003] Key pads can be included in electronic devices such as mobile phones to provide a user input for the electronic device. One type of key pad is a UVMP (Ultraviolet Cured Mold Print) key caps. Typically, key caps made from UVMP are made of a material that is relatively soft and flexible such as urethane material. The relatively soft flexible key cap allows the individual keys to actuate (e.g., move up and down) without pulling on adjacent keys. However, relatively soft key caps mark and scratch easily resulting in poor wear resistance.

SUMMARY

[0004] In certain embodiments, a method of manufacturing a key pad includes forming a plurality of upper key portions (e.g., key tops) comprising a first material that has a first hardness, and forming a plurality of lower key portions (e.g., key bottoms) comprising a second material that has a second hardness lower than the first hardness. Each of a plurality of keys includes one of the plurality of lower key portions and one of the plurality of upper key portions, and a plurality of such keys are attached to a flexible connecting member to form a key pad.

[0005] In certain embodiments, a method of manufacturing a key pad includes dispensing a first liquid material into a plurality of key cap mold cavities and dispensing a second liquid material into the plurality of key cap mold cavities after dispensing the first material into the plurality of key cap mold cavities. The method can include placing a
flexible connecting member over the plurality of key cap mold cavities. Furthermore, the method includes forming a first material from the first liquid material and forming a second material from the second liquid material. The first material and second material form a plurality of key caps mechanically coupled to the flexible connecting member. The first material has a first hardness, and the second material has a second hardness lower than the first hardness.

[0006] In certain embodiments, a key pad is provided. The key pad can include a plurality of key caps comprising a key top comprising a first material and a key bottom comprising a second material. The key bottom is coupled to the key top, and the first material has a first hardness, and the second material has a second hardness lower than the first hardness. The key pad further includes a flexible connecting member coupled to the key bottom of the plurality of key caps. In some embodiments, the first material and/or the second material comprise an ultraviolet light cured material.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Figure 1A is a perspective view of an example embodiment of a key pad with a plurality of key caps with a key top and a key bottom in accordance with certain embodiments described herein.

[0008] Figure 1B is a cross-sectional view of the key pad of Figure 3A taken through line IB-IB.

[0009] Figure 1C is a cross-sectional view of an example embodiment of a key pad with a thin layer to improve adhesion between the key caps and the flexible connecting member in accordance with certain embodiments described herein.

[0010] Figure 2 is a flow diagram of an example method compatible with certain embodiments described herein.

[0011] Figures 3A-E are cross-sectional views of an example method of forming a keypad in accordance with certain embodiments described herein.

[0012] Figure 4A is a cross-sectional view of an example embodiment of an assembly with a key cap in accordance with certain embodiments described herein.

[0013] Figure 4B is a cross-sectional view of the assembly of Figure 4A wherein a key cap is moved down.
[0014] Figure 5 is a perspective view of an example embodiment of a device that includes a key cap in accordance with certain embodiments described herein.

DETAILED DESCRIPTION

[0015] One type of key pad includes UVMP (Ultraviolet Cured Mold Print) key caps. The UVMP key caps are produce by dispensing metered volume of a liquid (e.g., fluid) material into a machined and/or polished negative image mold. After the liquid material (e.g., monomer, polymer, urethane, modified urethane) is dispensed, a flexible connecting member (e.g., cap sheet or carrier cap sheet) is placed over the liquid in the mold.

[0016] The cap sheet is then squeegee to obtain a generally flat surface smooth contact with the liquid. The liquid material is then cured (e.g., polymerized). Some liquid materials are polymerized using ultraviolet (UV) light. A flat sheet (e.g., glass) can be put on top of the cap sheet to maintain a smooth flat surface while going through a UV curing oven (e.g., reactor oven). After liquid material has polymerized or cured, the liquid material will become a cured material (e.g., polymer, cross-linked polymer) or other solid material at about room temperature. The cured material can then be removed from the mold to form key caps. The key caps can adhere and/or be mechanically coupled or attached to the cap sheet. In addition, after curing, the liquid material may shrink or have its volume reduced. The volume shrinkage can improve the ability to remove the cured key caps from the mold.

[0017] Key caps made from UVMP can be made of a material that is relatively soft and flexible. An urethane material is commonly used. After the urethane material is cured, the key caps can have a Shore hardness D scale of about 60 to about 80. The relatively soft flexible key cap allows the individual keys to actuate (e.g., move up and down) without pulling on adjacent keys. However, relatively soft key caps mark and scratch easily resulting in poor wear resistance.

[0018] In certain embodiments discussed below, one or more key caps have two or more different materials within each key cap. Figures 1A illustrates a perspective view of an example embodiment of a key pad 300 that includes a plurality of key caps 102, and a flexible connecting member 104. Each key cap 102 comprises a key top 106 (e.g., upper key portion, or part of the key cap 102 furthest from the flexible connecting member 104) and a key bottom 108 (e.g., lower key portion, or part of the key cap 102 closest to the flexible
connecting member 104). Figure 1B illustrates a cross-sectional view through the key pad 100 of Figure IA. Each key top 106 can include a first material with a first hardness, and each key bottom 108 can include a second material with a second hardness. In certain embodiments, the first hardness is higher than the second hardness. In further embodiments, the key top 106 comprises about one-half of the key cap 102, and the key bottom 108 comprises about one-half of the key cap 102. In other embodiments, the key top 106 comprises a relatively thin layer on the surface of the key cap 102, and the key bottom 108 comprises the remainder of the key cap 102. The first material can be, for example, acrylic, and the second material can be, for example, polyurethane. In certain embodiments, a third material is sandwiched between the key top 106 and the key bottom 108 to improve adhesion or attachment of the first material and the second material. In certain embodiments, the key cap 102 is substantially optically transparent (e.g. optically clear). For example, the first material and the second material are substantially optically transparent. Advantageously, a key cap with a relatively hard key top and a relatively flexible key bottom can be durable and scratch resistant while still allow individual keys to actuate without restriction.

[0019] In certain embodiments, the key pad 100 has a width of about 20 to about 40 mm and a length of about 45 and about 120 mm, and includes a plurality of key caps 102. In some embodiments, each of the key caps 102 have a width of about 5 to about 9 mm. The key top 106 has a first thickness, the key bottom 108 has a second thickness, and the key cap 102 has a total thickness comprising the first thickness and the second thickness. In certain embodiments, the second thickness can be at least one-third of the total thickness. In further embodiments, the second thickness is at least (e.g., greater than or equal) about one-half of the first thickness. In some embodiments, the key caps 102 have a total thickness of less than about 1 mm. In further embodiments, the key caps 102 have a total thickness of about 200 to about 500 microns. In one embodiment, the total thickness is about 300 microns.

[0020] Key caps 102 can have a variety of shapes including cylindrical, polygonal, dome shaped, etc. In some embodiments, an average width or cross-sectional area of the key top 106 is less than an average width or cross-sectional area of the key bottom 108. For example, a surface of the key cap 302 extending from the flexible connecting member
304 to the top of the key cap 102 may be angled or curved so that the cross-sectional area decreases between the bottom of the key bottom 108 to the top of the key top 106.

[0021] Distance between neighboring key caps 102 can also affect how much neighboring key caps 102 are displace or moved when a key cap 102 is actuated. In certain embodiments, the distance between neighboring key caps 102 is at least about 200 microns. In further embodiments, the distance between neighboring key caps 102 is about 200 to about 500 microns. In one embodiment, the distance between neighboring key caps 102 is about 300 microns.

[0022] The flexible connecting member 104 (e.g., cap sheet) can include materials such as polyethylene terephthalate (PET), polyurethane (TPU), and polycarbonate (PC). In certain embodiments, the flexible connecting member has a thickness between about 25 and 50 microns. In one embodiment, the thickness of the flexible connecting member is at least about 38 microns.

[0023] A key cap 102 with two or more materials can be produced through a variety of methods. Figure 2 is a flow diagram of an example method 200 compatible with certain embodiments described herein. In an operational block 202, a plurality of key cap mold cavities is provided. The bottom of the key cap mold cavities can be filled with a first liquid material (see operational block 204) that will form a first material and then the remaining of the key cap mold cavities can be filled with a second liquid material (see operational block 206) that will form a second material. In operational block 208, a flexible connecting member is placed over the plurality of key cap mold cavities. A first material can be formed from the first liquid material, a second material can be formed from the second liquid material, and the first material and the second material can form a plurality of key caps mechanically coupled to the flexible connecting member (see operational block 210). In certain embodiments, both the first liquid material and the second liquid material can be UV curable so that both materials are cured in the same curing process (e.g., a UVMP method) to form a plurality of key caps comprising the first material and the second material. In other embodiments, the first liquid material and second liquid material are thermally cured. Key cap mold cavities can have a shape such as to form the shape of the key caps. In operational block 212, the plurality of key caps can be removed from the plurality of key cap mold
cavities. For example, when the flexible connecting member is laid on top of the plurality of key cap mold cavities before forming the second material, the key caps with the flexible connecting member can be removed in a sheet format after the second material is formed.

[0024] In certain embodiments, a method of manufacturing a key pad includes forming a plurality of key tops comprising a first material that has a first hardness, and forming a plurality of key bottoms comprising a second material that has a second hardness lower than the first hardness. Each of a plurality of keys includes one of the plurality of lower key portions and one of the plurality of upper key portions, and a plurality of such keys are attached to a flexible connecting member to form a key pad. In certain embodiments, the one of the plurality of lower key portions is sandwiched between the one of the plurality of the upper key portions and the flexible connecting member.

[0025] Figures 3A-E illustrate an example embodiment of a method of forming a key pad 300. A plurality of key cap mold cavities 302 can be partially filled with a first liquid material 304 (see Figure 3A). A second liquid material 306 can fill the remaining of the plurality of key cap mold cavities 302 (see Figure 3B). A flexible connecting member 308 can be placed over the plurality of key cap mold cavities 302 (see Figure 3C). The first liquid material 304 and the second liquid material 306 can form a first material 310 and a second material 312, respectively (see Figure 3D). The first material 310 and the second material 312 form a plurality of key caps 314. The key caps 314 can be removed form the key cap mold cavities 302 to form a key pad 300.

[0026] In certain embodiments, the first material 310 is formed before the second liquid material 306 is dispensed into the key cap mold cavities 302. For example, the second liquid material 306 can be dispensed onto the first material 310.

[0027] The key pad 300 can also be formed using a first plurality of key cap mold cavities and a second plurality of key cap mold cavities. In certain other embodiments, the first plurality of key cap mold cavities can be filled with the second liquid material. The flexible connecting member can be placed over the plurality of key cap mold cavities. The second liquid material can form the second material 312 and be mechanically coupled to the flexible connecting member. The second plurality of key cap mold cavities can be filled with the first liquid material. The second material 312 can be placed over the second plurality of
key cap mold cavities and placed into contact with the first liquid material. The first liquid material can then form the first material 310, and the first material 310 and the second material 312 form the plurality of key caps 314.

[0028] In certain embodiments, the flexible connecting member 308 is coated or pretreated with a thin layer (e.g., about 10 to about 30 microns) of a third liquid material (e.g., UVMP) before being placed over the plurality of key cap mold cavities. The third liquid material can be, for example, the same liquid material as the first liquid material or the second liquid material. The third liquid material could also be a different liquid material than the first liquid material or the second liquid material. In some embodiments, the third liquid material is UV curable. The third liquid material can be formed into a third material. For example, the third material can be formed in the same process that the second material and/or first material are formed. Figure 1C is an example embodiment of a key pad 150 with a third material 152 sandwiched between the key caps 154 and the flexible connecting member 156. The third material 152 can improve adhesion between the flexible connecting member 156 and the key caps 154.

[0029] As described above, the first material can have a first hardness, and the second material can have a second harness that is less than the first hardness. Hardness is the measure of a material’s resistance to deformation by surface indentation or by abrasion. Hardness can be measured by a number of ways. In certain embodiments, the first hardness is appropriate for testing under Shore D hardness testing and the second hardness is appropriate for testing under Shore A hardness testing. Shore A hardness can be measured with a Shore A durometer, and Shore A hardness can be measured with a Shore D durometer. In further embodiments, the first hardness has a hardness value between about 60 and about 80 Shore D, and the second harness has a harness value between about 60 and about 70 Shore A. In one embodiment, the first hardness has a hardness value of about 80 Shore D, and the second harness has a harness valued of about 70 Shore A.

[0030] Figure 4A illustrates an example embodiment of a cross-sectional view of an assembly 400 with a key pad 401 in accordance with certain embodiments described herein. The key pad 401 includes a plurality of key caps 402 mechanically coupled to a flexible connecting member 403. For example, the plurality of key caps 402 can be
mechanically coupled to the flexible connecting member 403 with a third material (e.g., urethane) sandwiched between the plurality of key caps 402 and the flexible connecting member 403 (see, e.g., Figure 1C). Each key cap 402 includes a key top 405 and a key bottom 407. The flexible connecting member 403 can be mechanically coupled to a flexible display 409. For example, the flexible display 409 can be mechanically coupled (e.g., laminated) to the flexible connecting member 403 with an optically transparent adhesive (OTA) or UV curable glue 411. The flexible display 409 can be any type of display that can flex when a key cap 402 is pressed, such as those described below. The flexible display 409 can, for example, display icons underneath the key caps 402. The flexible display 409 could also be replace with flexible member that has printed icons. The assembly 400 can also include a dome sheet 413 to measure if a key cap 402 is pressed or actuated down. The dome sheet 413 can include domes 415 that can, when pressed, short a circuit on a flexible printed circuit assembly (FPCA) 417. The dome sheet 413 can be, for example, a mylar sheet with pressure sensitive adhesive (PSA) to adhere to the FPCA 417. A gasket 419 can be sandwiched between the flexible display 409 and the dome sheet 413 to provide separation between the dome sheet 413 and the flexible display 409. In certain embodiments, the FPCA 417 is mechanically coupled to a rigid support member. The assembly 400 can also be sandwiched between the rigid support member and a front housing member to mechanically retain components of the assembly 400 together.

[0031] Figure 4B illustrates the assembly 400 of Figure 4A wherein one of the key caps 402 is pressed, represented by an arrow 421. When a key cap 402 is pressed, the key bottom 407, flexible connecting member 403, OTA 411, and flexible display 409 can flex and apply a force to a dome 415 so that an input can be measured that the key cap 402 has been pressed. As described above, the key bottom 407 can deform when the key cap 402 is pressed. A key cap that includes a stiff or rigid key top and key bottom would pull neighboring keys down when it was pressed. In particular, a pressed key cap can pull on the flexible connecting member 403 and the flexible display 409 which can cause the neighboring (e.g., adjacent) key caps 402 to be pulled. By having a key bottom 407 that can deform when the key cap 402 is pressed, the amount that neighboring keys are pulled down can be decreased compared to a key cap with a rigid key bottom. Furthermore, by having a
relatively softer key bottom 407 than the key top 405. The key cap 402 can flex which can improve tactility.

[0032] As described above, the key caps 402 can be positioned over a flexible display 409. The flexible display 409 can emit light that passes through the key caps 102. For example, the flexible display 409 can be an electroluminescent display, a segmented electroluminescent display, liquid crystal display, a combination electroluminescent and liquid crystal display, etc. Further examples of flexible displays 409 are described in U.S. Patent No. 6,777,884 and 7,088,039, the entirety of each of which is hereby incorporated by reference. Figure 5 illustrates an example embodiment of a device 500 that include a keypad 501 such as those described above.

[0033] Various embodiments have been described above. Although the invention has been described with reference to these specific embodiments, the descriptions are intended to be illustrative and are not intended to be limiting. Various modifications and applications may occur to those skilled in the art without departing from the true spirit and scope of the invention as defined in the appended claims.
WHAT IS CLAIMED IS:

1. A method of manufacturing a key pad comprising:
   forming a plurality of upper key portions comprising a first material that has a first hardness;
   forming a plurality of lower key portions comprising a second material that has a second hardness lower than the first hardness; and
   wherein each of a plurality of keys includes one of the plurality of lower key portions and one of the plurality of upper key portions, and a plurality of such keys are attached to a flexible connecting member to form a key pad.

2. The method of Claim 1, wherein the first material and the second material are formed using ultraviolet light.

3. The method of Claim 1, wherein the first material and the second material are substantially optically transparent.

4. The method of Claim 1, wherein the first material comprises acrylic.

5. The method of Claim 1, wherein the second material comprises polyurethane.

6. The method of Claim 1, wherein the first material comprises acrylic and the second material comprises polyurethane.

7. A method of manufacturing a key pad comprising:
   dispensing a first liquid material into a plurality of key cap mold cavities;
   dispensing a second liquid material into the plurality of key cap mold cavities after dispensing the first liquid material into the plurality of key cap mold cavities;
   placing a flexible connecting member over the plurality of key cap mold cavities;
   forming a first material from the first liquid material;
   forming a second material from the second liquid material; and
   wherein the first material and second material form a plurality of key caps mechanically coupled to the flexible connecting member, and the first material has a first hardness and the second material has a second hardness lower than the first hardness.
8. The method of Claim 7, wherein the first liquid material and the second liquid material are both dispensed into the plurality of key cap mold cavities prior to forming the first material and the second material.

9. The method of Claim 8, wherein the first liquid material and the second liquid material are formed in a same ultraviolet light curing process.

10. The method of Claim 7, wherein the second liquid material is dispensed onto the first liquid material.

11. The method of Claim 7, further comprising dispensing a third liquid material sandwiched between the first liquid material and the second liquid material.

12. The method of Claim 7, wherein forming the first material comprises polymerizing the first liquid material, and forming the second material comprises polymerizing the second liquid material.

13. A key pad comprising:
   a plurality of key caps comprising:
       a key top comprising a first material;
       a key bottom comprising a second material, the key bottom coupled to the key top, and the first material having a first hardness and the second material having a second hardness lower than the first hardness; and
       a flexible connecting member coupled to the key bottom of the plurality of key caps.

14. The key pad of Claim 13, wherein the first material and the second material comprises an ultraviolet light cured material.

15. The key pad of Claim 13, wherein the first material has a first Shore hardness and the second material has a second Shore hardness lower than the first Shore hardness.

16. The key pad of Claim 13, wherein the first hardness is appropriate for testing under Shore D hardness testing and the second hardness is appropriate for testing under Shore A hardness testing.

17. The key pad of Claim 13, wherein the first hardness is between about 60 and about 80 Shore D hardness and the second hardness is between about 60 and about 70 Shore A hardness.
18. The key pad of Claim 13, wherein the key top comprises a first thickness and the key bottom comprises a second thickness, the second thickness is at least about one-half the first thickness.

19. The key pad of Claim 13, wherein the first material and the second material are substantially optically transparent.

20. The keypad of Claim 13, wherein the first material comprises acrylic.

21. The key pad of Claim 13, wherein the second material comprises polyurethane.

22. The key pad of Claim 13, wherein the first material comprises acrylic and the second material comprises polyurethane.

23. The key pad of Claim 13, further comprising a third material sandwiched between the first material and the second material.
Provide a plurality of key cap mold cavities

Dispense a first liquid material into the plurality of key cap mold cavities

Dispense a second liquid material into the plurality of key cap mold cavities

Place a flexible connecting member over the plurality of key pad mold cavities

Form a first material from the first liquid material, form a second material from the second liquid material, and wherein the first material and the second material form a plurality of key caps mechanically coupled to the flexible connecting member

Remove the flexible connecting member and the plurality of key caps from the plurality of key pad mold cavities

FIG. 2
INTERNATIONAL SEARCH REPORT

International application No
PCT/US2010/0038429

A CLASSIFICATION OF SUBJECT MATTER

IPC(8) - H04M 1/00 (2010.01)
USPC - 379/433.07

According to International Patent Classification (IPC) or to both national classification and IPC

B FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) - H04M 1/00 (2010.01)
USPC - 379/368, 369, 370, 433.07

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PatBas, Google Patents

C DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No</th>
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<tr>
<td>X</td>
<td>US 6,023,033 A (YAGI et al) 08 February 2000 (08 02 2000) entire document</td>
<td>1, 3, 4, 7, 8, 10-13, 15-20, 23</td>
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<td>Y</td>
<td>US 6,723,936 B2 (OOTSUKA et al) 20 April 2004 (20 04'2004) entire document</td>
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D Further documents are listed in the continuation of Box C

*T later document published after the international filing date or prior to date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search
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