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(54) **CURVED TOUCH SENSOR**

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***H05K 3/00*** (2006.01)

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USPC ..... **427/162**; 427/98.2; 349/159

(58) **Field of Classification Search**
USPC ..... 349/158, 110; 427/58, 98.2, 162
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

| | | | | |
|---|---|---|---|---|
| 5,188,692 | A * | 2/1993 | Horvath | 156/212 |
| 5,483,261 | A | 1/1996 | Yasutake | |
| 5,488,204 | A | 1/1996 | Mead et al. | |
| 5,825,352 | A | 10/1998 | Bisset et al. | |
| 5,835,079 | A | 11/1998 | Shieh | |
| 5,880,411 | A | 3/1999 | Gillespie et al. | |
| 6,188,391 | B1 | 2/2001 | Seely et al. | |
| 6,310,610 | B1 | 10/2001 | Beaton et al. | |
| 6,323,846 | B1 | 11/2001 | Westerman et al. | |
| 6,690,387 | B2 | 2/2004 | Zimmerman et al. | |
| 7,015,894 | B2 | 3/2006 | Morohoshi | |
| 7,184,064 | B2 | 2/2007 | Zimmerman et al. | |
| 7,663,607 | B2 | 2/2010 | Hotelling et al. | |
| 8,479,122 | B2 | 7/2013 | Hotelling et al. | |
| 2003/0030760 | A1 * | 2/2003 | Nishiki | 349/43 |
| 2006/0026521 | A1 | 2/2006 | Hotelling et al. | |
| 2006/0197753 | A1 | 9/2006 | Hotelling | |
| 2007/0045264 | A1 * | 3/2007 | Nekoda et al. | 219/203 |
| 2009/0273584 | A1 * | 11/2009 | Staton et al. | 345/178 |
| 2010/0103138 | A1 * | 4/2010 | Huang et al. | 345/174 |

FOREIGN PATENT DOCUMENTS

| | | | |
|---|---|---|---|
| JP | 2000-163031 | A | 6/2000 |
| JP | 2002-342033 | A | 11/2002 |

OTHER PUBLICATIONS

Lee, S.K. et al. (Apr. 1985). "A Multi-Touch Three Dimensional Touch-Sensitive Tablet," *Proceedings of CHI: ACM Conference on Human Factors in Computing Systems*, pp. 21-25.

(Continued)

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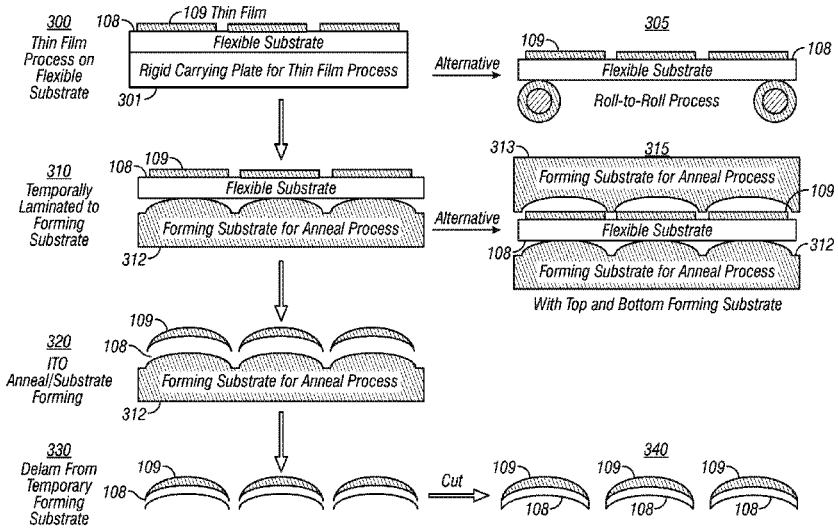
(57) **ABSTRACT**

A method of forming a curved touch surface is disclosed. The method can include depositing and patterning a conductive thin film on a flexible substrate to form at least one touch sensor pattern, while the flexible substrate is in a flat state. According to certain embodiments, the method can include supporting the flexible substrate in the flat state on at least one curved forming substrate having a predetermined curvature; and performing an anneal process, or an anneal-like high-heat process, on the conductive thin film, wherein the anneal process can cause the flexible substrate to conform to the predetermined curvature of the at least one curved forming substrate. According to an embodiment, the curved forming substrate can include a first forming substrate having a first predetermined curvature and a second forming substrate having a second predetermined curvature complementing the first predetermined curvature.

**19 Claims, 5 Drawing Sheets**