APPARATUSES AND METHODS FOR FORMING ASSEMBLIES

[0001] This application claims the benefit of the earlier filing date of co-pending provisional application of Jeffrey Jay Jacobsen entitled, "Apparatuses and Methods for Forming Assemblies" filed Feb. 5, 1999, Ser. No. 60/118,887 and incorporated herein by reference.

BACKGROUND INFORMATION

[0002] This application claims the benefit of the earlier filing date of co-pending provisional application of Jeffrey Jay Jacobsen entitled, "Apparatuses and Methods for Forming Assemblies," Ser. No. 60/118,887, filed Feb. 5, 1999 and incorporated herein by reference.

[0003] 1. Field of the Invention

[0004] The present invention relates generally to the field of fabricating assemblies such as display panels. More particularly, the present invention relates to apparatuses and methods for (1) forming a flexible active matrix display along a length of a flexible substrate; (2) forming multiple displays along a continuous flexible substrate; (3) forming a flexible display along a flexible reflective substrate; (4) using fluidic self-assembly (FSA) generally with a flexible web process material; (5) using FSA and a deterministic method, such as "pick and place," to place objects onto a rigid substrate or onto a web process material; and, (6) using web processing to deposit and/or pattern display material through an in-line process.

[0005] 2. Description of Related Art

[0006] Fabrication of display panels is well known in the art. Display panels may be comprised of active matrix or passive matrix panels. Active matrix panels and passive matrix panels may be either transmissive or reflective. Transmissive displays include polysilicon thin-film transistor (TFT) displays, and high-resolution polysilicon displays. Reflective displays typically comprise single crystal silicon integrated circuit substrates that have reflective pixels.

[0007] Liquid crystals, electroluminescent (EL) materials, organic light emitting diodes (OLEDs), up and downconverting phosphor (U/DCP), electrophoretic (EP) materials, or light emitting diodes (LEDs) may be used in fabricating flat-panel display panels. Each of these is known in the art and is discussed briefly below.

[0008] Liquid crystal displays (LCDs) can have an active-matrix backplane in which thin-film transistors are co-located with LCD pixels. Flat-panel displays employing LCDs generally include five different components or layers: a White or sequential Red, Green, Blue light source, a first polarizing filter, that is mounted on one side of a circuit panel on which the TFTs are arrayed to form pixels, a filter plate containing at least three primary colors arranged into pixels, and a second polarizing filter. A volume between the circuit panel and the filter plate is filled with a liquid crystal material. This material will rotate the polarized light when an electric field is applied between the circuit panel and a transparent ground electrode affixed to the filter plate or a cover glass. Thus, when a particular pixel of the display is turned on, the liquid crystal material rotates polarized light being transmitted through the material so that it will pass through the second polarizing filter. Some liquid crystal materials, however, require no polarizers. Polarizers are made by a company known as SRI. LCDs may also have a passive matrix backplane which is usually two planes of strip electrodes which sandwich the liquid crystal material. However, passive matrices generally provide a lower quality display compared to active matrices. Liquid crystal material includes, but is not limited to, twisted nematic (TN), Super TN, double STN, and ferroelectric. U/DCP and EP displays are formed in a similar fashion except the active medium is different (e.g., upconverting gas, downconverting gas, electrophoretic materials).

[0009] EL displays have one or more pixels that are energized by an alternating current (AC) that must be provided to each pixel by row and column interconnects. EL displays generally provide a low brightness output because passive circuitry for exciting pixel phosphors typically operates at a pixel excitation frequency that is low relative to the luminance decay time of the phosphor material. However, an active matrix reduces the interconnect capacitance allowing the use of high frequency AC in order to obtain more efficient electroluminescence in the pixel phosphor. This results in increased brightness in the display.

[0010] LED displays are also used in flat-panel displays. LEDs emit light when energized. OLEDs operate like the LEDs except OLEDs use organic material in the formation of the diode.

[0011] Regardless of the type of active medium used, displays are generally comprised of at least a substrate and a backplane. The backplane forms the electrical interconnection of the display and comprises electrodes, capacitors, and transistors in at least some embodiments of a backplane.

[0012] **FIG. 1A** illustrates a rigid display device wherein the active matrix display backplane **10** is coupled to a rigid substrate **12**. Typically, the active matrix display backplane is also rigid. **FIG. 1B** shows another rigid display. There, the active matrix display backplane **10** is coupled to a rigid substrate **12** (e.g., glass). Also shown is a plurality of blocks **14**. These blocks may be fabricated separately and then deposited into holes on substrate **12** by a process known as fluidic self assembly; an example of this process is described in U.S. Pat. No. 5,545,291. These blocks may each contain driver circuitry (e.g., MOSFET and capacitor) for driving a pixel electrode. The active matrix backplane includes transparent pixel electrodes and row/column interconnects (not shown) to electrically interconnect the blocks **14**. The plurality of blocks **14** is coupled to the active matrix display backplane **10** and the rigid substrate **12**. **FIG. 1C** shows a reflective display **16** coupled to a rigid substrate **12**. **FIG. 1D** shows a reflective display **16** coupled to a rigid substrate **12**. A plurality of blocks **14** is coupled to the reflective display **16** and to the rigid substrate **12**.

[0013] Placing elements, such as pixel drivers, on a rigid substrate is well known. Prior techniques can be generally divided into two types: deterministic methods or random methods. Deterministic methods, such as pick and place, use a human or robot arm to pick each element and place it into its corresponding location in a different substrate. Pick and place methods generally place devices one at a time and are generally not applicable to very small or numerous elements such as those needed for large arrays, such as an active matrix liquid crystal display.

[0014] Random placement techniques are more effective and result in high yields if the elements to be placed have the