

people of a coming hurricane. For automotive and truck use, the windshield can now fulfill all of the functions that previously have required a heads up display (HUD). These include displays of any information that a driver may want or need including the gages normally on the instrument panel, displaying the results of a night vision camera and, if an occupant sensor is present, an image of an object, or an icon representation, can be displayed on the windshield where the driver would see it if it were visible through the windshield as discussed in more detail elsewhere herein and in the commonly assigned cross referenced patents and patent applications listed above. In fact, plastic electronics have the ability to cover most or even the entire windshield area at very low cost and without the necessity of an expensive and difficult to mount projection system. In contrast, most HUDs are very limited in windshield coverage. Plastic electronics also provide for a full color display, which is difficult to provide with a HUD since the combiner in the HUD is usually tuned to reflect only a single color.

[0255] In addition to safety uses, turning one or more windows of a house or vehicle into a display can have "infotainment" and other uses. For example, a teenager may wish to display a message on the side windows to a passing vehicle such as "hi, can I have your phone number?" The passing vehicle can then display the phone number if the occupant of that vehicle wishes. A vehicle or a vehicle operator that is experiencing problems can display "HELP" or some other appropriate message. The occupants of the back seat of a vehicle can use the side window displays to play games or search the Internet, for example. Similarly, a special visor like display based of plastic electronics can be rotated or pulled down from the ceiling for the same purposes. Thus, in a very cost effective manner, any or all of the windows or sun visors of the vehicle (or house or building) can now become computer displays and thus make use of previously unused surfaces for information display.

[0256] In another application, a portion of the windshield, such as the lower left corner, can be used to display the vehicle and surrounding vehicles or other objects as seen from above, for example, as described in U.S. patent application Ser. No. 09/851,362 filed May 8, 2000 which is incorporated herein by reference in its entirety. This display can use pictures or icons as appropriate. In another case, the condition of the road such as the presence, or likelihood of black ice can be displayed on the windshield where it would show on the road if the driver could see it. Naturally, this would require a source of information that such a condition exists, however, here the concern is that it can be displayed whatever the source of this or any other relevant information. When used in conjunction with a navigation system, directions including pointing arrows can be displayed to direct the driver to his destination or to points of interest.

[0257] Plastic electronics is in an early stage of development but will have an enormous impact on the windows, sunroofs and sun visors of vehicles. For example, researchers at Philips Research Laboratories have made a 64x64-pixel liquid crystal display (LCD) in which each pixel is controlled by a plastic transistor. Other researchers have used a polymer-dispersed liquid-crystal display (PDLCD) to demonstrate their polymeric transistor patterning. A PDLCD is a reflective display that, unlike most LCD technologies, is not based on polarization effects and so can be used to make a flexible display that could be pulled down like a shade, for

example. In a PDLCD, light is either scattered by non-aligned molecules in liquid-crystal domains or the LC domains are transparent because an electrical field aligns the molecules.

[0258] Pentacene (5A) and sexithiophene (6T) are currently the two most widely used organic semiconductors. These are two conjugated molecules whose means of assembly in the solid state lead to highly orderly materials, including even the single crystal. The excellent transport properties of these molecules may be explained by the high degree of crystallinity of the thin films of these two semiconductor components.

[0259] The discovery of conducting polymers has become even more significant as this class of materials has proven to be of great technological promise. Conducting polymers have been put to use in such niche applications as electromagnetic shielding, antistatic coatings on photographic films, and windows with changeable optical properties. The undoped polymers, which are semiconducting and sometimes electroluminescent, have led to even more exciting possibilities, such as transistors, light-emitting diodes (LEDs), and photodetectors. The quantum efficiency (the ratio of photons out to electrons in) of the first polymer LEDs was about 0.01%, but subsequent work quickly raised it to about 1%. Polymer LEDs now have efficiencies of above about 10%, and they can emit a variety of colors. The upper limit of efficiency was once thought to be about 25% but this limitation has now been exceeded and improvements are expected to continue.

[0260] A screen based on PolyLEDs has advantages since it is lightweight and flexible. It can be rolled up or embedded into a windshield or other window. With plastic chips the electronics driving the screen are integrated into the screen itself. Some applications of the PolyLED are information screens of almost unlimited size, for example alongside motorways or at train stations. They now work continuously for about 50,000 hours, which is more than the life of an automobile. Used as a display, PolyLEDs are much thinner than an LCD screen with backlight.

[0261] The most important benefit of the PolyLED is the high contrast and the high brightness with the result that they can be easily read in both bright and dark environments, which is important for automotive applications. A PolyLED does not have the viewing angle problem associates with LCDs. The light is transmitted in all directions with the same intensity. Of particular importance is that PolyLEDs can be produced in large quantities at a low price. The efficiency of current plastic electronic devices depends somewhat on their electrical conductivity, which is currently considerably below metals. With improved ordering of the polymer chains, however, the conductivity is expected to eventually exceed that of the best metals. Plastic electronics can be made using solution based processing methods, such as spincoating, casting, and printing. This fact can potentially reduce the fabrication cost and lead to large area reel-to-reel production. In particular, printing methods (particularly screen printing) are especially desirable since the deposition and patterning steps can be combined in one single step. Screen printing has been widely used in commercial printed circuit boards and was recently adopted by several research groups to print electrodes as well as the active polymer layers for organic transistors and simple circuits. Inkjets and