

insulator 11, and first semiconductor 6. Absorber 2 may be a semiconductor and may completely fill layer 'f'.

[0056] Optionally, photovoltaic device 40 may comprise a substrate 9 in layer 'g'. Substrate 9 may be configured and disposed to have first contact 8 deposited thereon and support layers 'a'-'f'. In at least one aspect of the present disclosure, photovoltaic device 40 is void of substrate 9 and first contact 8 may be configured and disposed to support layers 'b'-'f', for example contact 8 may comprise a thick contact material. Second layer 'b' may be disposed on and/or adjacent to first layer 'a', the third layer 'c' may be disposed on and/or adjacent to second layer 'b', fourth layer 'd' may be disposed on and/or adjacent to third layer 'c', fifth layer 'e' may be disposed on and/or adjacent to fourth layer 'd', and sixth layer 'f' may be disposed on and/or adjacent to fifth layer 'e'. In at least one aspect, photovoltaic device 40 has substrate 9 in layer 'g' upon which may dispose layer 'a'.

[0057] FIG. 4a shows a top view of photovoltaic device 40 having absorber 2 removed therefrom. In this respect, a portion of layer 'e' is shown having contact material 4 and a portion of layer 'b' is shown having semiconductor 6. In this aspect shown in FIG. 4a, electrode or contact material 4 may comprise a group of wires 3, which may be attached to each other by a contact pad 7, thus forming the second electrode or contact 4. However, the presently disclosed photovoltaic device may have most any arrangement of contact 4. For example, contact 4 may be in the form of a grid of wires 3. The pitch of photovoltaic device 40 may be defined as the distance between centers of adjacent wires 3. For purposes of the present disclosure, the pitch may range from tens of nanometers to tens of micrometers. In the aspect of the photovoltaic device shown here, photovoltaic device 40, absorber 2 extends into semiconductor 6 and comprises a portion of layer 'c'.

[0058] Thin film photovoltaic device 40 with back contacts 8 and 4 comprises a first contact 8 disposed in first layer 'a' and has an upper surface and a lower surface. Semiconductor 6 is disposed in second layer 'b' and a portion of third layer 'c' and has a lower surface disposed on the upper surface of the first contact 8. Insulator 11 is disposed in a fourth layer 'd' and on an upper surface of the semiconductor 6. Second contact 4 is disposed in a fifth layer 'e' and on insulator 11. Absorber 2 completely fills sixth layer 'f' and is disposed about second contact 4, insulator 11, and semiconductor 6. Second layer 'b' may be adjacent first layer 'a', third layer 'c' may be adjacent second layer 'b', fourth layer 'd' may be adjacent third layer 'c', fifth layer 'e' may be adjacent fourth layer 'd', and sixth layer 'f' may be adjacent fifth layer 'e'.

[0059] Absorber 2 of photovoltaic device 40 may comprise a p-type semiconductor or a n-type conductor and semiconductor 6 may comprise the other of the p-type semiconductor and n-type conductor. Insulator 11 may be disposed in fourth layer 'd' and may be configured to insulate against direct electrical communication between semiconductor 6 and second contact 4 and ensure electrical communication between first contact 8 and second contact 4 solely through semiconductor 6 and absorber 2. Photovoltaic device 30 may comprise substrate 9 and first contact 8 may have its lower surface disposed on substrate 9. Second contact 4 may have an interrupted pattern and thereby only partially filling fifth layer 'e' and absorber 2 may fill the interrupts in second contact 4, interrupts in insulator 11, and a portion of layer 'c' comprising semiconductor material 6.

[0060] Photovoltaic device 40 may comprise a first electrode 8 disposed in first layer 'a', semiconductor 6 disposed in second layer 'b' on first electrode 8 and a portion of third layer 'c', insulator 11 may have an interrupted pattern and may be disposed in fourth layer 'd' on semiconductor 6, second electrode 4 may be disposed in fifth layer 'e' and only on insulator 11, absorber 2 may entirely fill sixth layer 'f' and be disposed on second electrode 4 and may fill the interrupted patterns of insulator 11 and second electrode 4 and may fill a portion of layer 'c'. Insulator 11 may be comprised of a non-conducting and non-semiconducting materials. For example, insulator 11 may consist of SiO₂. Absorber 2 may comprise a p-type semiconductor or a n-type conductor and semiconductor 6 may comprise the other of the p-type semiconductor and n-type conductor.

[0061] FIGS. 5a and 5b show photovoltaic device 50 with back contacts 4 and 8. FIG. 5b is a cross-sectional view of photovoltaic device 50 showing layers 'a'-'f'. Photovoltaic device 50 may be a thin film photovoltaic device and may comprise a first contact 8 disposed in a first layer 'a' and having an upper surface and a lower surface, as shown in FIG. 5b. A first semiconductor 6 may be disposed in a second layer 'b' and have a lower surface disposed on the upper surface of the first contact 8. Second semiconductor 5 may be disposed in third layer 'c' and on an upper surface of the first semiconductor 6. Second semiconductor 5 may comprise, or consist of, the same material as absorber 2, or may comprise, or consist of, different material. In at least one aspect of device 50, absorber 2 comprises a p-type semiconducting material and second semiconductor 5 comprises a different p-type semiconducting material. In at least one other aspect of device 50, absorber 2 comprises a n-type semiconducting material and second semiconductor 5 comprises a different n-type semiconducting material. In at least one additional aspect of device 50, absorber 2 and second semiconductor 5 comprise the same material. Second contact 4 may be disposed in a portion of a fourth layer 'd' and on semiconductor 5. Second contact 4 may be in the form of a perforated sheet or sheet having an array of holes, as shown in FIG. 5b. Absorber 2 may comprise a second semiconductor and may be disposed in a fifth layer 'e' and a portion of layer 'd' and about second contact 4 and second semiconductor 5. Absorber 2 may be a semiconductor and may completely fill layer 'e' and the array of holes in second contact 4.

[0062] Optionally, photovoltaic device 50 may comprise a substrate 9 in layer 'f'. Substrate 9 may be configured and disposed to have first contact 8 disposed and/or deposited thereon and support layers 'a'-'e'. In at least one aspect of the present disclosure, photovoltaic device 50 is void of substrate 9 and first contact 8 may be configured and disposed to support layers 'b'-'e', for example contact 8 may comprise a thick contact material. Second layer 'b' may be disposed on and/or adjacent to first layer 'a', the third layer 'c' may be disposed on and/or adjacent to second layer 'b', fourth layer 'd' may be disposed on and/or adjacent to third layer 'c', and fifth layer 'e' may be disposed on and/or adjacent to fourth layer 'd'.

[0063] FIG. 5a shows a top view of photovoltaic device 50 having absorber 2 removed therefrom. In this respect, a portion of layer 'd' is shown having contact material 4 and a portion of layer 'c' is shown having second semiconductor 5. In this aspect, electrode or contact material 4 may comprise a perforated sheet or a sheet with an array of holes, thus forming the second electrode or contact 4. The array of holes may be