

# Exhibit 13



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(54) **ENERGY CONVERSION AND STORAGE FILMS AND DEVICES BY PHYSICAL VAPOR DEPOSITION OF TITANIUM AND TITANIUM OXIDES AND SUB-OXIDES**

**Related U.S. Application Data**

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**Publication Classification**

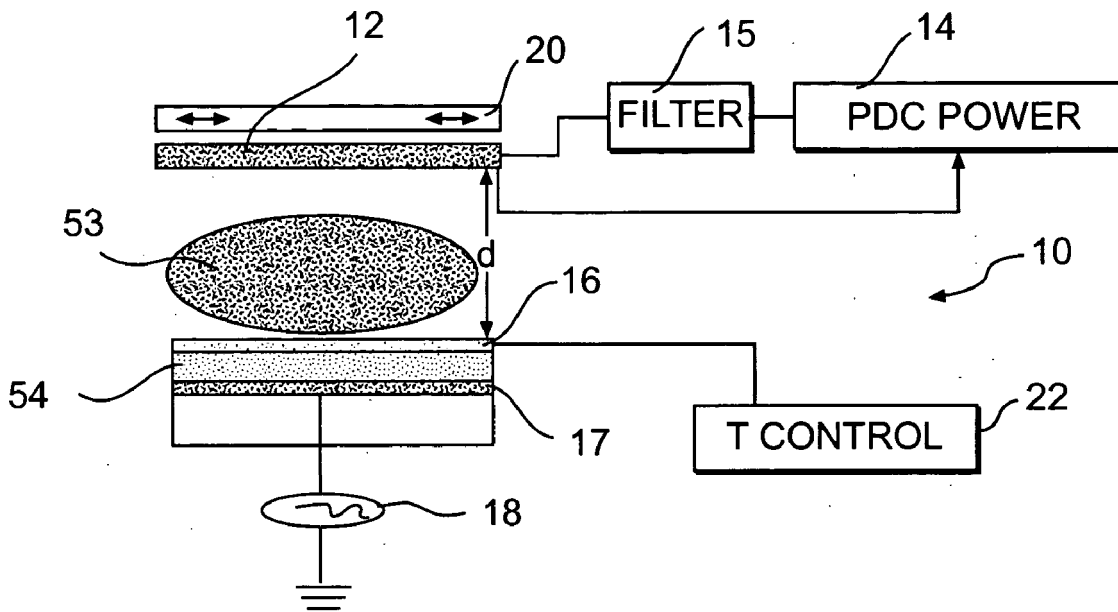
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 (52) **U.S. Cl.** ..... **438/240; 438/685; 438/785**

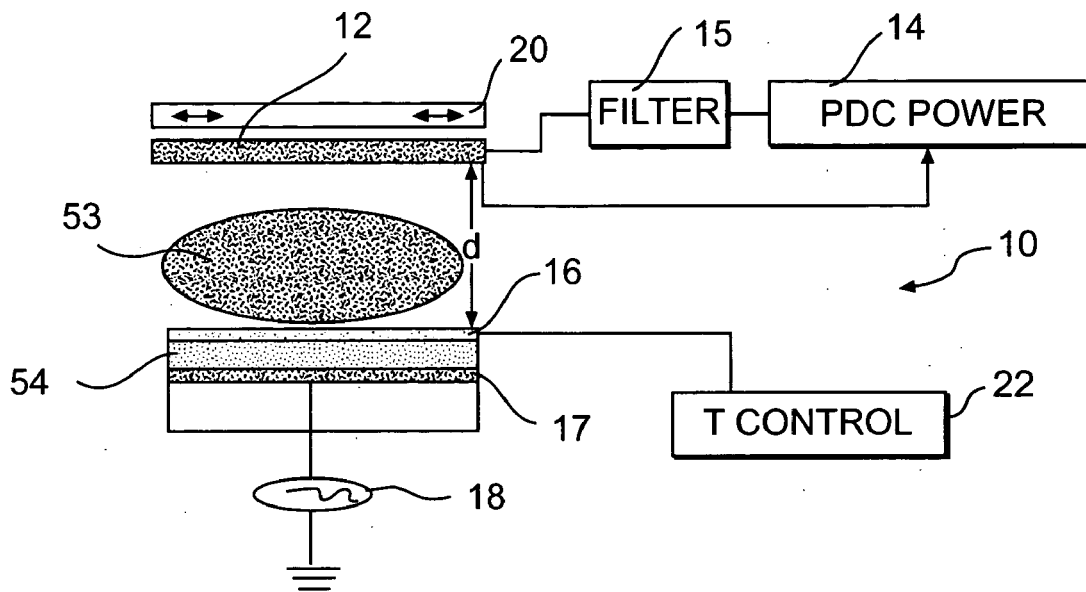
(57) **ABSTRACT**  
 High density oxide films are deposited by a pulsed-DC, biased, reactive sputtering process from a titanium containing target to form high quality titanium containing oxide films. A method of forming a titanium based layer or film according to the present invention includes depositing a layer of titanium containing oxide by pulsed-DC, biased reactive sputtering process on a substrate. In some embodiments, the layer is TiO<sub>2</sub>. In some embodiments, the layer is a sub-oxide of Titanium. In some embodiments, the layer is Ti<sub>x</sub>O<sub>y</sub> wherein x is between about 1 and about 4 and y is between about 1 and about 7. In some embodiments, the layer can be doped with one or more rare-earth ions. Such layers are useful in energy and charge storage, and energy conversion technologies.

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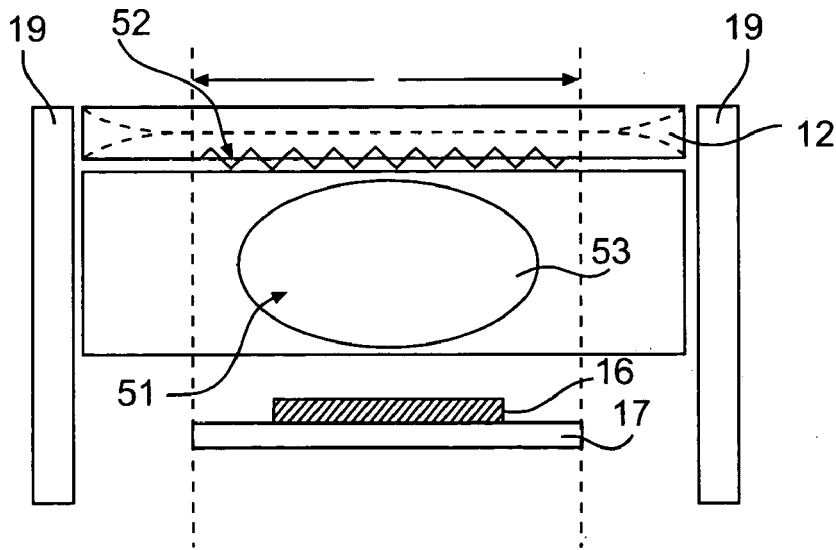
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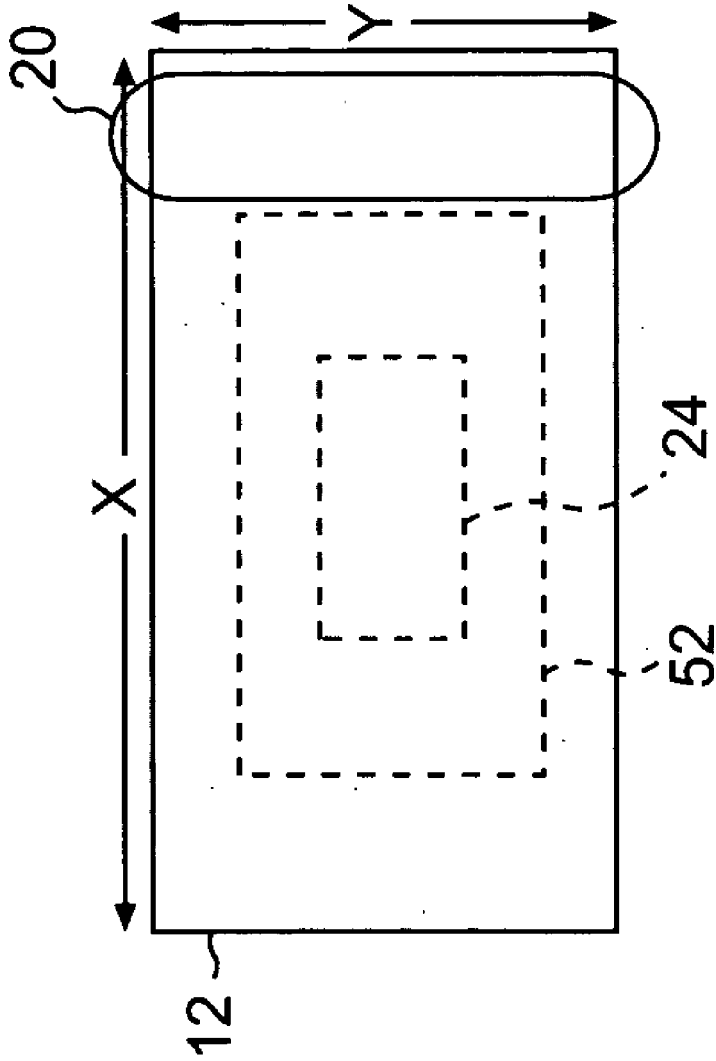




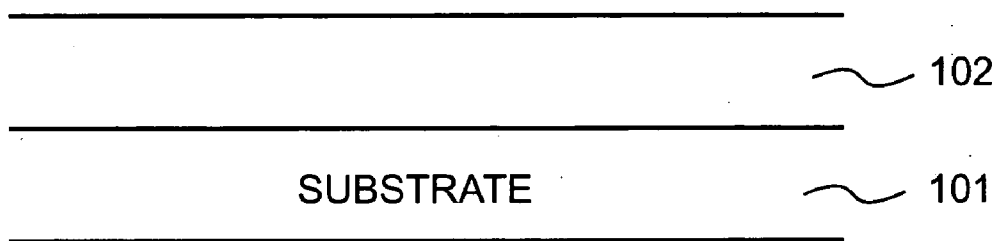
**FIG. 1A**



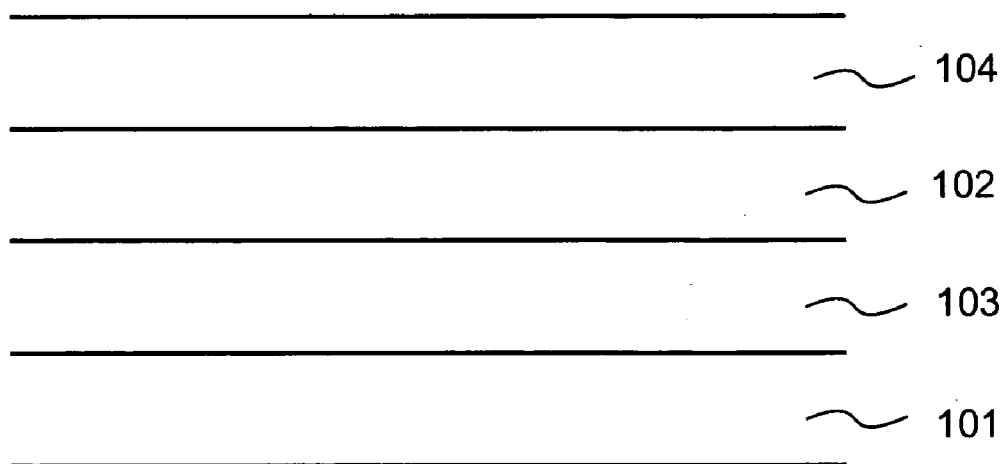
**FIG. 1B**



**FIG. 2**



**FIG. 3A**



**FIG. 3B**

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