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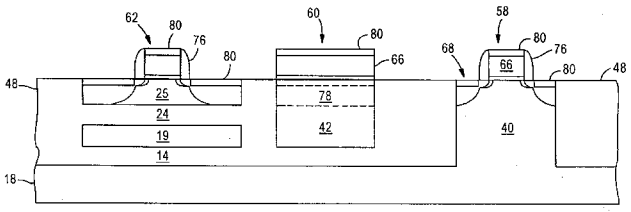
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(54) Title: SEMICONDUCTOR DEVICE AND METHOD OF MAKING SEMICONDUCTOR DEVICE COMPRISING MULTIPLE STACKED HYBRID ORIENTATION LAYERS



(57) Abstract: A semiconductor device comprising a substrate 18 having a first crystal orientation is provided. A first insulating layer 14 overlies the substrate 18 and a plurality of silicon layers overlie the first insulating layer 14. A first silicon layer 42 comprises silicon having a second crystal orientation and a crystal plane. A second silicon layer 25 comprises silicon having the second crystal orientation and a crystal plane that is substantially orthogonal to the crystal plane of the first silicon layer 42. Because holes have higher mobility in the (110) plane, semiconductor device performance can be enhanced by the selection of silicon layers with certain crystal plane orientations. In addition, a method of forming a semiconductor device is provided. A silicon-on-insulator structure comprising a first silicon substrate 18 having a first crystal orientation with a first insulating layer 14 formed thereon and a first silicon layer 19 having a second crystal orientation and a crystal plane overlying the first insulating layer 14 is bonded to a second silicon substrate 20. The second silicon substrate 20 has the second crystal orientation and a crystal plane and a second insulating layer 24 formed thereon. The second silicon substrate 20 comprises a line of defects 22 created by implanting hydrogen ion into the second silicon substrate 20. The crystal plane of the second silicon substrate 20 is oriented substantially orthogonal to the crystal plane of the first silicon layer 19. The second silicon substrate 20 is split and removed alonf the line of defects 22 leaving behind the second insulating layer 24 and a second silicon layer 25 on the silicon-on-insulator structure. A plurality of devices with different crystal orientations can be subsequently formed on a single, planar silicon-on-insulator structure by selectively etching the silicon-on-insulator structure down to silicon layers of different crystal orientations, growing selective epitaxial silicon layers in the etched regions, and subsequently planarizing the silicon-on-insulator structure by chemical-mechanical polishing.

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