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[54] **SELECTIVE DEPOSITION OF DOPED SILICON-GERMANIUM ALLOY ON SEMICONDUCTOR SUBSTRATE, AND RESULTING STRUCTURES**

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Related U.S. Application Data

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[52] **U.S. Cl.** **257/19**; 257/65; 257/382; 257/742; 257/755

[58] **Field of Search** 257/65, 66, 382, 383, 257/384, 377, 385, 388, 411, 412, 413, 410, 19, 754, 742, 743

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,442,449	4/1984	Lehrer et al.	357/67
4,619,038	10/1986	Pintchovski	29/590
5,168,072	12/1992	Moslehi	437/41

FOREIGN PATENT DOCUMENTS

3-172421 7/1991 Japan .

OTHER PUBLICATIONS

Sangameria et al., "Rapid Thermal Chemical Vapor Deposition of in-situ Boron Doped Polycrystalline Si_xGe_{1-x}" *Journal of Electronic Materials*, vol. 21, No. 1 pp. 61-64, Jan., 1992.

Ashburn et al., "Formation of Titanium and Cobalt Germanides on Si(100) Using Rapid Thermal Processing," *Journal of Electronic Materials*, vol. 21, No. 1, pp. 81-86, Jan., 1992.

Selective Low-Pressure Chemical Vapor Deposition of $Si_{1-x}Ge_x$ Alloys in a Rapid Thermal Processor Using Dichlorosilane and Germane, Y. Z. Mehmet et al., Appl. Phys. Lett. 57 (20), Nov., 1990, pp. 2092-2094.

Selective Ge Deposition on Si Using Thermal Decomposition of GeH_4, H. Ishii et al., Appl. Phys. Lett. 47 (8), Oct. 1985, pp. 863-865.

A Polycrystalline-$Si_{1-x}Ge_x$-Gate CMOS Technology, T. King et al., IEDM 90, pp. 253-256, 1990.

Rapid Thermal Chemical Vapor Deposition of Germanium on Silicon and Silicon Dioxide and New Applications on Ge in ULSI Technologies, M. C. Ozturk et al., Journal of Electronic Materials, vol. 19, No. 10, 1990, pp. 1129-1134.

(List continued on next page.)

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[57] **ABSTRACT**

Doped silicon-germanium alloy is selectively deposited on a semiconductor substrate, and the semiconductor substrate is then heated to diffuse at least some of the dopant from the silicon-germanium alloy into the semiconductor substrate to form a doped region at the face of the semiconductor substrate. The doped silicon-germanium alloy acts as a diffusion source for the dopant, so that shallow doped, regions may be formed at the face of the semiconductor substrate without ion implantation. A high performance contact to the doped region is also provided by forming a metal layer on the doped silicon-germanium alloy layer and heating to react at least part of the silicon-germanium alloy layer with at least part of the metal layer to form a layer of germanosilicide alloy over the doped regions. The method of the present invention is particularly suitable for forming shallow source and drain regions for a field effect transistor, and self-aligned source and drain contacts therefor.

12 Claims, 7 Drawing Sheets