



US00RE34861E

United States Patent [19]

[11] E

Patent Number: **Re. 34,861**

Davis et al.

[45] Reissued Date of Patent: **Feb. 14, 1995**

[54] **SUBLIMATION OF SILICON CARBIDE TO PRODUCE LARGE, DEVICE QUALITY SINGLE CRYSTALS OF SILICON CARBIDE**

62-66000 3/1987 Japan .
63-283014 11/1988 Japan 437/100

[75] Inventors: **Robert F. Davis; Calvin H. Carter, Jr., both of Raleigh; Charles E. Hunter, Durham, all of N.C.**

[73] Assignee: **North Carolina State University, Raleigh, N.C.**

[21] Appl. No.: **594,856**

[22] Filed: **Oct. 9, 1990**

OTHER PUBLICATIONS

Tairov et al.; Progress in Controlling the Growth of Polytypic Crystals; Electrical Eng. Institute, Leningrad, p-22, 197022 USSR; Aug. 24, 1982; pp. 111-161.
Tairov et al.; General Principles of Growing Large-Size Single Crystals of Various Silicon Carbide Polytypes; Jnl of Crystal Growth 52 (1981), pp. 146-150.
Scace et al.; Solubility of Carbon in Silicon and Germanium; Jnl of Chemical Physics, vol. 60, No. 6, Jun., 1959, pp. 1551-1555.

Ziegler et al.; Single Crystal Growth of SiC Substrate Material for Blue Light Emitting Diodes; Trans. on Electron Devices, vol. ED-30, No. 4, Apr. 1983, pp. 277-281.

Thermal Oxidation of 3C Silicon Carbide Single-Crystal Layers on Silicon; Fung et al.; Appl. Phys. Lett. 45(7), Oct. 1, 1984; pp. 757-759.

Metal-Oxide-Semiconductor Characteristics of Chemical Vapor Deposited Cubic-SiC; Shibahara et al.; Japanese Jnl. of Appl. Physics; vol. 23, No. 11, pp. L862-L864, Nov. 1984.

C-V Characteristics of SiC Metal-Oxide-Semiconductor Diode with a Thermally Grown SiO₂ Layer; Suzuki et al.; Appl. Phys. Lett. vol. 39, No. 1; Jul. 1, 1981; pp. 89-90.

Thermal Oxidation of SiC and Electrical Properties of Al-SiO₂-SiC MOS Structure; Suzuki et al.; Jap. Jnl. of Appl. Physics; vol. 21, No. 4, 4-82; pp. 579-585.

Behavior of Inversion Layers in 3C Silicon Carbide; Avila et al.; Appl. Phys. Lett. 49(6); Aug. 11, 1986; pp. 334-336.

Primary Examiner—George Fourson

Attorney, Agent, or Firm—Bell, Seltzer, Park & Gibson

[57]

ABSTRACT

The present invention is a method of forming large device quality single crystals of silicon carbide. The sublimation process is enhanced by maintaining a constant polytype composition in the source materials, selected size distribution in the source materials, by specific preparation of the growth surface and seed crystals, and by controlling the thermal gradient between the source materials and the seed crystal.

Related U.S. Patent Documents

Reissue of:

[64] Patent No.: **4,866,005**
Issued: **Sep. 12, 1989**
Appl. No.: **113,565**
Filed: **Oct. 26, 1987**

[51] Int. Cl.⁶ **H01L 21/365**

[52] U.S. Cl. **437/100; 117/105**

[58] Field of Search **148/DIG. 148; 156/610, 156/612, 614, DIG. 64, DIG. 68; 437/100; 117/105**

[56] References Cited

U.S. PATENT DOCUMENTS

2,854,364	9/1958	Lely	148/1.5
3,228,756	1/1966	Hergenrother	23/301
3,236,780	2/1966	Ozarow	427/43.1
3,511,614	5/1970	Wenckus et al. .	
3,558,284	1/1971	Wallis .	
3,615,930	10/1971	Knippenberg et al.	148/175
3,910,767	10/1975	Jemal .	
3,917,459	11/1975	Falckenberg et al. .	
3,960,503	6/1976	Rice .	
3,962,406	6/1976	Knippenberg et al.	148/175
4,108,670	8/1978	Steiger et al. .	
4,147,572	4/1979	Vodakov et al.	427/43.1
4,310,614	1/1982	Conwell et al. .	
4,556,436	12/1985	Addamiano	148/175
4,627,990	12/1986	Saga et al. .	
4,664,944	5/1987	Hsu et al.	427/87

FOREIGN PATENT DOCUMENTS

1467085	7/1964	Germany .
3230727	2/1984	Germany .
56-96883	8/1981	Japan .
59-35099	8/1982	Japan .

29 Claims, 3 Drawing Sheets

