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[54] METHOD FOR PRODUCING LOW THERMAL BUDGET FERROELECTRIC THIN FILMS FOR INTEGRATED DEVICE STRUCTURES USING LASER-CRYSTALLIZATION OF SPIN-ON SOL-GEL FILMS

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[58] Field of Search 117/7, 89, 92; 264/345; 427/126.3

Bullington et al., "RT-66A Standardized Ferroelectric Tester Operating Manual", Version 2.1, pp. 7-1 to 8-7.

Gifford et al. (1993), "Microstructure and Electrical Properties . . .", Mat. Res. Soc. Symp. Proc., vol. 243, pp. 191-196.

Okada et al., "Preparation of c-Axis-Oriented PbTiO₃ . . .", Jap. J. Appl. Phys., 1989, vol. 28, p. 1030.

Sankur et al. (1985), "Thin Film Deposition by Laser Assisted Evaporation", Appl. Optics, vol. 24, No. 20, pp. 3343-3347.

Schwartz et al. (1992), "Spectroscopic and Microstructural Characterization of Solution . . .", Mat. Res. Soc. Proc., vol. 243, pp. 245-261.

Scott et al. (1991), "Quantitative Measurement of Space-Charge Effects . . .", Journal of Applied Physics, vol. 70, pp. 382-388.

(List continued on next page.)

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[56] References Cited

U.S. PATENT DOCUMENTS

4,331,485	5/1982	Gat	437/1.6
4,375,993	3/1983	Mori et al.	437/1.9
4,523,962	6/1985	Nishimura	437/174
4,900,581	2/1990	Stuke et al.	427/555
4,946,710	8/1990	Miller et al.	427/126.3
5,028,455	7/1991	Miller et al.	427/126.3
5,116,643	5/1992	Miller et al.	427/126.3
5,146,299	9/1992	Lampe et al.	257/295
5,188,902	2/1993	Lin	428/426
5,198,269	3/1993	Swartz et al.	427/226
5,299,309	3/1994	Kato	395/162
5,348,775	9/1994	Lin	427/555

OTHER PUBLICATIONS

Arlt et al. (1988), "Internal Bias in Ferroelectric Ceramics . . .", Ferroelectrics vol. 87, 1988, pp.109-120.

Banas et al. (1982), "Macro-Materials Processing", Proceedings of the IEEE, vol. 70, No. 6, pp. 556-565.

Bondurant, "Ferroelectric RAM Memory Family . . .", Proceedings of the First Symposium . . . , Mar. 1989, Colorado Springs, pp. 212-215.

[57] ABSTRACT

A method for developing large area highly oriented polycrystalline ferroelectric thin films using spin-on sol-gel deposition and laser crystallization techniques that allow for precise control of temperature distribution. The present invention improves quality, reliability, performance and cost effective production of ferroelectric non-volatile random access memory (FNVRAM) on thermally sensitive silicon and gallium arsenide semiconductor substrates compatible with very large scale integrated circuit technologies. The method is time effective, as crystallization is performed in three seconds as compared to thirteen hours in a conventional furnace for 1 cm×1 cm wafer. In addition, crystallization of the film is further achieved without exposing the underneath device structure to detrimental high temperature annealing conditions. The present invention results in minimization of thermal budget, interdiffusion of substrates/electrodes/films and phase segregation, and increased compatibility of PZT ferroelectric thin films with thermally sensitive semiconductor substrates.

20 Claims, 1 Drawing Sheet

