A Study of Threshold Voltage Prediction by Fuzzy and Neural Network in Submicron MOSFETs

徐惇穎、陳勝利

E-mail: 8804785@mail.dyu.edu.tw

ABSTRACT

ABSTRACT In recent years, a MOSFET dimension in ultra large-scale integrated circuits (ULSI ’ s) have been kept shrinking in order to achieve higher device/circuit density and to reduce the product costs. It is well known that the threshold voltage Vth of a small device will be distinguish from that of a long or wide device, which was due to the short-channel effect (SCE), narrow-width effect (NWE), reverse short-channel effect (RSCE), and reverse narrow-width effect (RNWE). This thesis proposes a new methodology to predict the anomalous threshold voltage behaviors of submicrometer MOSFETs by using the fuzzy theory and neural network. The linearly extrapolated method " LE method " has been used to extract the threshold voltage from the MOSFET Ids-Vgs characteristics, therefore, the threshold voltage of a MOSFET will be obtained. Similarly, the same procedure can be used to extract the corresponding threshold voltage of MOSFET devices with different geometry dimension. Futhermore, first, the channel width W is setted to be constant, and then the relation of threshold voltages versus channel lengths can be obtained. Next step, the channel length L is setted to be constant, meanwhile, the relation of threshold voltages versus channel widths will be obtained. All the experiment data of threshold voltages can be treated as the training data, afterward an iterative learning keeps processing until the error percentages converged. Then, we can build up a fuzzy system with new rules. Base on these rules, any arbitrary input of channel length and channel width will be resulted in a prediction value of threshold voltage. Therefore, it can be concluded that this architecture is used to develop the complex threshold voltage behaviors cause by the devices geometry effect in our work. A good agreement has been obtained as comparing the prediction results and the experiment data. Finally, in the same token, we can extend this procedure to analyze and predict the other complex physical parameters in WAT module of an IC company.

Keywords : Fuzzy Theory ; Neuro Network ; Grey System

Table of Contents

REFERENCES

參 考 文 獻 [1] 張俊彥主編，鄭晃忠審校，「積體電路製程及設備技術手冊」；1998年經濟部技術處、中華民國產業科發展協進會、中華民國電子材料與元件協會出版發行。

[2] 施敏原著，張俊彥譯著，「半導體元件物理及製作技術」；1996年，高立出版社出版。

[3] B.J.Sheu,D.L.Scharfetter,P.K.Ko, and M.C.Jeng," BSIM:Berkeley short-channel IGFET model for MOS Transistors",IEEEJ.Solid- State Circuits, SC-22 pp.558-565,1987.

[4] P.T.Lai and Y.C.Cheng, "An Analytical Model for the Narrow- Width Effect in Ion-Implanted MOSFETs, " Solid-State Electron.,vol.27,pp.639-643,1984.

[5] Chih-Yuan LU,and J.M.Sung "Reverse short channel effects on thresholds voltages in submicrometer Salicide devies",IEEE Electron.,Vol.10, pp.446-448,1989.

[6] L.A.Akers and J.J.Sanchez,"Threshold voltage modelof short, narrow and small geometry MOSFET's:a reviews ",Solid-State Electron.,25, pp.621-641,1982.

[7] L. D. Yau, "A Simple Theory to Predict the Threshold voltage of Short-channel IGFET', " Solid state Electron., vol.17,pp.1059(1974).
[8] ASTM Standard F617, " Standard method for measuring MOSFET linear threshold voltage ", 1988 Annual Book of ASTM Standards, Am. Soc. Test. Mat., Philadelphia , 1988.
[9] A. B. Fowler, and A. M. Hartstein, "Techniques for determining threshold" Surface Sci .98, pp.33-55, 1979.
[10] Dieter K. Schroder, " Semiconductor material and device characterization ", John Wiley, New York, pp.183-184,1990.
[11] " Neuro-Fuzzy AND Soft Computing" by J. S. R. JANG, C. T. SUN, E. MIZUTANI.
[12] Fuzzy Logic Toolbox for use with MATLAB , The Math Works , Inc., 1995.
[13] Neural Network Toolbox for use with MATLAB , The Math Works, Inc., 1994.
[14] 華建智，葉豐輝，蔡慧駿，李經綸，"適應性類神經模糊控 制系統於盲用點字印表機之應用"，1998自動控制研討會， pp.294-299。
[15] Detlef Nauck,Rudolf Kruse,"A Neural Fuzzy Controller Learning by Fuzzy Error Propagation", NAFIP '92, Puerto, pp.183-184 Mexico, Dec14-17 .
[16] M.SUGENO and C.T.KANG, "STRUCTURE IDENTIFICATION OF FUZZY MODEL",Elsevier Science Publishers B.V.,1988.
[17] ASTM Standard F617, "Standard method for measuring MOSFET linear threshold ", 1988 Annual Book of ASTM Standards, Am.Soc.test.Mat., Philadelphia, 1998.
[18] H. S. Wong, M. H. White, T. J. Krutsick, and R. V. Booth, "Modeling of Transconductance Degradation and Extraction of Threshold Voltage in Thin Oxide MOSFETs ", Solid State Electron.30, pp.953-968,Sept.1987.
[19] Troutman,r.r.,and Fortino,A.G., "Simple model for threshold voltage in a short-channel IGFET ", IEEE Trans., ED- 24,10, pp.1266-1268, 1977.
[20] Wu, Y., and Hsu, K.C., "A new threshold-voltage method for small-geometry buried-channel MOSFET's", Solid-State Electron.,12,pp.1283-1289,1985.
[21] A. B. Fowler, and A. M. Hartstein, "Techniques for determining threshold", Surface Sci., 98, pp.33-35, 1979.
[22] Deng Julong, "Application of Grey System Theory in China", IEEE, pp.285-291, 1990.
[23] 康億毅，徐演政，"GM模型對台灣股市平均數據處理之探 討", 1997年灰色系統理論與應用研討會論文集，pp.73-79。
[24] 鄧聚龍、郭洪編著，"灰預測原理與應用"，全華科技圖書股 份有限公司發行。
[25] 吳漢雄、鄧聚龍、溫坤禮編著，"灰色分析入門"，高力圖書 有限公司出版。