



An Implantable Release-on-Demand CMOS Drug Delivery SoC Using Electrothermal Activation Technique

YU-JIE HUANG, HSIN-HUNG LIAO, and PEN-LI HUANG, National Taiwan University
TAO WANG, Chang Gung University
YAO-JOE YANG, National Taiwan University
YAO-HONG WANG, National Taiwan University Hospital
SHEY-SHI LU, National Taiwan University

An implantable system-on-a-chip (SoC) integrating controller/actuation circuitry and 8 individually addressable drug reservoirs is proposed for on-demand drug delivery. It is implemented by standard 0.35- μm CMOS technology and post-IC processing. The post-IC processing includes deposition of metallic membranes (200Å Pt/3000Å Ti/200Å Pt) to cap the drug reservoirs, deep dry etching to carve drug reservoirs in silicon as drug containers, and PDMS layer bonding to enlarge the drug storage. Based on electrothermal activation technique, drug releases can be precisely controlled by wireless signals. The wireless controller/actuation circuits including on-off keying (OOK) receiver, microcontroller unit, clock generator, power-on-reset circuit, and switch array are integrated on the same chip, providing patients the ability of remote drug activation and noninvasive therapy modification. Implanted by minimally invasive surgery, this SoC can be used for the precise drug dosing of localized treatment, such as the cancer therapy, or the immediate medication to some emergent diseases, such as heart attack. In vitro experimental results show that the reservoir content can be released successfully through the rupture of the membrane which is appointed by received wireless commands.

Categories and Subject Descriptors: B.7.m [Integrated Circuits]: Miscellaneous

General Terms: Design, Experimentation, Human Factors, Performance

Additional Key Words and Phrases: Biocompatibility, CMOS SoC, drug delivery, electrothermal, implantable, post-IC

ACM Reference Format:

Huang, Y.-J., Liao, H.-H., Huang, P.-L., Wang, T., Yang, Y.-J., Wang, Y.-H., and Lu, S.-S. 2012. An implantable release-on-demand CMOS drug delivery SoC using electrothermal activation technique. *ACM J. Emerg. Technol. Comput. Syst.* 8, 2, Article 12 (June 2012), 22 pages.
DOI = 10.1145/2180878.2180884 <http://doi.acm.org/10.1145/2180878.2180884>

A short version of this article appeared in *Proceedings of the IEEE International Solid-State Circuit Conference (ISSCC'09)*.

This work was supported by the National Science Council under the grant number NSC97-2221E002-153-MY3, NSC 99-2218-E-182-010.

Authors' addresses: Y.-J. Huang, P.-L. Huang, and S.-S. Lu, Graduate Institute of Electronics Engineering, National Taiwan University, Taipei 10617, Taiwan; email: sslu@ntu.edu.tw; H.-H. Liao and Y.-J. Yang, Department of Mechanical Engineering, National Taiwan University, Taipei 10617, Taiwan; yjy@ntu.edu.tw; T. Wang, Department of Electronic Engineering, Chang Gung University, Kwei-Shan Tao-Yuan, Taiwan; email: tw@mail.cgu.edu.tw; Y.-H. Wang, Department of Medical Imaging, National Taiwan University Hospital, Taipei, Taiwan; email: yhwang@ntu.edu.tw.

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies show this notice on the first page or initial screen of a display along with the full citation. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, to republish, to post on servers, to redistribute to lists, or to use any component of this work in other works requires prior specific permission and/or a fee. Permissions may be requested from the Publications Dept., ACM, Inc., 2 Penn Plaza, Suite 701, New York, NY 10121-0701, USA, fax +1 (212) 869-0481, or permissions@acm.org.

© 2012 ACM 1550-4832/2012/06-ART12 \$10.00

DOI 10.1145/2180878.2180884 <http://doi.acm.org/10.1145/2180878.2180884>