1. Title
Smallest Nanoelectronics with Adatom Chains

2. Author
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3. Conference
A conference talk will be given at NanoSpace-98 of NASA Johnson Space Center, November 1-6, 1998. I do not submit a proceedings paper although authors were invited to do so. Therefore, none of the slides will be published.

5. About VI author/originator verification in form1676
(1) There is no export controlled, confidential commercial information.
(2) Regarding the patent, the technical field covered here is related to ARC-14246, "Doping Method of Semiconducting Atomic Chains." This is a talk only, without a proceedings paper (abstract was submitted last spring, and form 1676 was filed and approved at that time), and ARC-14246 covers the content. The talk is focused on the general aspect of atomic chain electronics that I have been studying for last three years. Results have been published before, but are being rederived here using a new physical/mathematical picture/model, which deepens the physical understanding. The content is protected from a patent point of view.

6. Slides
See the attached copy.
RTOP # 519-40-12 Description

RTOP # 519-40-12 authorizes Code IN work by the Application Analysis and Tools (AAT) Group in partial fulfillment of Information Technology (IT) program objectives documented in the IT Program Statement, cf. Sec. 2.1.1.1. Technology dissemination is authorized under guidelines set forth in Sec. 5.0 “Technology Transfer/Sensitive Data Control”. The IT program is currently administered by acting program manager Eugene Tu (ext. 4-4486).

The document entitled “Smallest Nanoelectronics with Adatom Chains”, written by Toshishige Yamada, conforms to Sec. 5.0 guidelines, and contains no material under direct or indirect control of the U.S. Commerce Department.
4. Conduction quantization

3. Lateral coherent coupling

2. Vertical I-V spectroscopy with STM

1. Atom manipulation with STM

Rapid progress in STM experimentation

Small set electronics with precise structures

Controlled
- Predictable
- Uniform

Uncontrolled
- Unpredictable
- Nonuniform

Meso: 10.8 - 10.7 m

Alumina: > 10 m

Almost disconnected atomic wire

Muller, van Ruitenbeek, E de Jonge. PRL 69, 140 (92)

Stricoso, Feeherr. A PRL. 79 A 5, 436 (87)

I. Lateral coherent coupling

Model field. CA 94035-1000

MRT NASA Ames Research Center M5-T27-A1

Toshishige Yamada

with Atomic Chain

with Nanoelectronics

Kubiy. Wang, G Freeman. PRB 43, 946 (96)

Beeler, Cooper, Huthorn. SI 11th 77 (7)

H. Oh. SI: 11th 77 (7)

Re om CA:

I. L. Sasse: 19, 135 (93)

Crommelin, Lutt. E. Egfer, Science 262, 218 (93)

SI 11th 271 (86)

SI 11th 269 (85)
Geometry
Doping scheme: $n$ and $d$-semiconductors
Electronics: Atomic scale electronics

Solid state electronics

Metal-insulator transition
Hybridization
Natural $p$

$3D$ diamond

$2D$ array

$p$-band crossing
$s$-band crossing

$p$-band, $s$-band

$3D$ chain

$2D$ array

$1D$ chain

$gap$

$p$-large $p$-small

$p$-large $p$-small

Metallic regardless of $p$

Semiconducting regardless of $p$

$1D$ ME chain

$1D$ ME chain

Floating or chemical bonding

Substrate as a template

Precise structures

Spacings $p$ = Electronic properties
Substrate effects

Atomic modulation doping - least band deformation

4p, 5s band with acceptor X1 and donor P

Large

Small

E-p crossing

S1 3s

S1 3p
d 3p

S1 3d

2 each

2 each

n/channel

22 Si atoms

edge state due to H

H atom

2.1 Functional

Doping

Available for chain

1. Reduce orbitals

Second layer silicon

First layer silicon

Hydrogen

Group I A alkali

Adhesion chain bound to

interface with hydrogen

 showcases hydrogen bonding sustained adhesion chain bound to interface Si (100)

Yamada, JPSJ 16, 1403 (68)
Towards devices with gain
Transport through junctions
Ohmic contact
Substrate effects
Future

Donors Group I, acceptors Group VII
Periodic, beside the chain:
Doping method:
Metal chain: semiconductor
So far

As a template - no uncertainty
Please adatom structures on a regulated surface

Summary

Potential blockade

Localised, small C
Inherent exchange

Extended, large C
Frequent exchange (Ohmic contact)

Al contact

Wave Function

Conditions for Shockley surface mode