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Charge Carrier Confinement in a Nano-patterned Silicon Film[1]

ZHENG LIU, Dept. of Material Science and Engineering, U. of Utah, Salt Lake City, UT, 84112 & Center for Advanced Study, Tsinghua Univ., Beijing, China, 100084, WENHUI DUAN, Department of Physics, Tsinghua University, Beijing, China, 100084, FENG LIU, Department of Material Science and Engineering, University of Utah, Salt Lake City, Utah, 84112, JIAN WU, Department of Physics, Tsinghua University, Beijing, China, 100084 — Impurity scattering is becoming a critical problem in sub- micrometer MOSFET. One way to reduce the impurity scattering is by separating carriers from dopants, as used in the modulation- doping technique. From first-principles calculation, we find that by etching channels along (001) direction on the surface of a thin (110) silicon film, the hole states can be strongly confined in the film underneath the patterned layer. Therefore, by seletive doping in the top patterned layer, a modulation- doping-like effect can be achieved which is expected to greatly enhance the hole mobility. This effect arises from matching between carrier wavefunction orientation and quantum confinement direction determined by film and pattern geometry. It will be functional as long as the patterned feature size is within a few nanometers.

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Zheng Liu
Dept. of Material Science and Engineering, U. of Utah &
Center for Advanced Study, Tsinghua Univ.

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