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(54) **ETCHING RADICAL CONTROLLED GAS
CHOPPED DEEP REACTIVE ION ETCHING**

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216/58; 216/66**

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(57) **ABSTRACT**

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A method for silicon micromachining techniques based on high aspect ratio reactive ion etching with gas chopping has been developed capable of producing essentially scallop-free, smooth, sidewall surfaces. The method uses precisely controlled, alternated (or chopped) gas flow of the etching and deposition gas precursors to produce a controllable sidewall passivation capable of high anisotropy. The dynamic control of sidewall passivation is achieved by carefully controlling fluorine radical presence with moderator gasses, such as CH₄ and controlling the passivation rate and stoichiometry using a CF₂ source. In this manner, sidewall polymer deposition thicknesses are very well controlled, reducing sidewall ripples to very small levels. By combining inductively coupled plasmas with controlled fluorocarbon chemistry, good control of vertical structures with very low sidewall roughness may be produced. Results show silicon features with an aspect ratio of 20:1 for 10 nm features with applicability to nano-applications in the sub-50 nm regime. By comparison, previous traditional gas chopping techniques have produced rippled or scalloped sidewalls in a range of 50 to 100 nm roughness.

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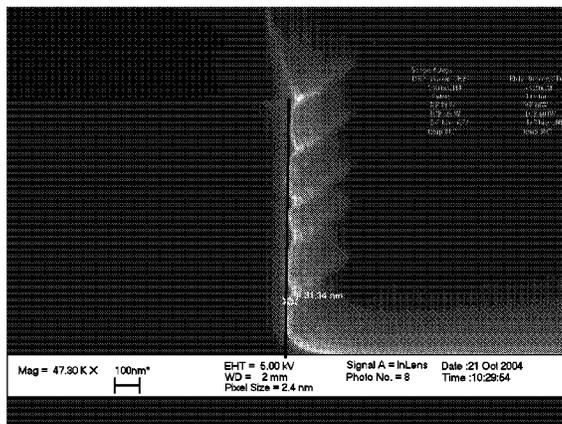
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5 repeat steps
DEP: 15sccm CHF3      Etch: 40 sccm SF6
      5sccm CH4        5 sccm Ar
      30mtorr          10 mtorr
      RF 10 W          RF 40W
      ICP 600W        ICP 600W
      DC bias 60V     DC bias 100V
      temp 10C        temp 10C
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