Practice quiz isotropic wet etching of silicon in the HNA bath

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Questions:

0 points possible (ungraded)

1. Which of the following is true for the mask material selection for the etching of Si in an HNA bath?

- ( ) Wet etching of SiO_2 is performed by adding an electrical contact to the Si wafer
- (•) For very deep etching, a Au or Si_3N_4 mask is needed
- ( ) Photoresists can be used as masking material, as they tolerate strong oxidizing agents like HNO_3
- ( ) One has to dip the wafer first in a pure HF bath, after which one dips it in a HNO_3 bath

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Explanation

If one is at the temperature where the Si etching rate is 50 μm/min, the SiO_2 etching rate is in between 30 to 80 nm/min, so that SiO_2 can be used as a mask material. For very deep etching, Au or Si_3N_4 masks are required, as regular photoresists cannot withstand strong oxidizing agents like HNO_3 in a HNA bath. See "Isotropic wet etching of silicon in the HNA bath" video from 9:30 to 10:20 for detailed explanations.

2. Which of the following is true for the current-voltage characteristic of a p-doped Si wafer that is put into a diluted HF solution, whereby one electrode is attached to the p-doped Si and the other electrode is placed in the diluted HF solution?

- (•) At large negative voltage values, electrical breakdown of the semiconductor occurs
- ( ) A positive voltage applied to the wafer transfers electrons to the interface and hence Si etching occurs
- ( ) Because of electro-polishing during positive voltage values, p-doped Si looks dark
- ( ) A negative voltage applied to the wafer causes the accumulation of electrons in the liquid at the wafer-HF bath interface

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Explanation

Suppose one has a p-doped Si wafer and when one attaches to it a conducting wire, to which one applies a positive voltage bias, holes will be transported into the Si and accumulate at the Si/electrolyte interface. These holes are essential for oxidation, after which the SiO_2 can be removed by a HF solution. Applying a positive voltage bias to an n-doped Si wafer causes a depletion of electrons in the Si at the Si/electrolyte interface. No etching will occur as no holes are present at the surface, except when the positive voltage is so high that an electrical breakdown occurs. Suppose now we have a p-doped Si wafer which is put into a diluted HF bath. A positive voltage transports holes to the interface and hence, etching occurs. More voltage means, more holes and more etching and an increase in current. If we apply a negative voltage, this attracts the holes to the wire, leaving a depletion of holes at the interface. No reaction is occurring and hence no current is occurring except if the voltage is so high that one has electrical breakdown. If one now shines light, the photons generate electron-hole pairs, the electrons of which stay at the interface and these electrons recombine with the protons from the electrolyte thereby generating H2 gas. In the positive part of the curve, the surface that was etched appears bright due to the high number of holes, as a result, electro-polishing occurs. See "Isotropic wet etching of silicon in the HNA bath" video from 11:15 to 16:55 for detailed explanations.

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