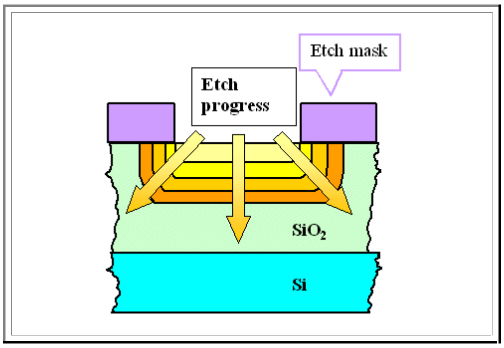
6.5.2 Chemical Etching

- Chemical etching is simple: Find some (liquid) chemical that dissolves the layer to be etched, but that does not react with everything else.
  - Sometimes this works, sometimes it doesn`t. Hydrofluoric acid (**HF**), for example will dissolve **SiO_2**, but not **Si** - so there is an etching solution for etching **SiO_2** with extreme selectivity to **Si**.
  - The other way around does not work: Whatever dissolves **Si**, will always dissolve **SiO_2**, too. At best you may come up with an etchant that shows somewhat different etching rates, i.e. some (poor) selectivity.
- Anyway, the thing to remember is: Chemical etchants, if existing, can provide extremely good selectivity and thus meet our *second* request from above.
  - How about the *first* request, anisotropy? Well, as you guessed: It is rotten, practically non-existent. A chemical etchant always dissolves the material it is in contact with, the forming of a contact hole would look like this:



- There is a simple and painful consequence: As soon as your feature size is about **2 µm** or smaller, *forget chemical structure etching*.
  - Really? How about making the opening in the mask smaller, accounting for the increase in lateral dimensions?
  - You could do that - it would work. But it would be foolish: If you *can* make the opening smaller, you also want your features smaller. In real life, you put up a tremendous effort to make the contact hole opening as small as you can, and you sure like hell don't want to increase it by the structure etching!
- Does that mean that there is no chemical etching in **Si** microelectronics? Far from it. There just is no chemical *structure* etching any more. But there are plenty of opportunities to use chemical etches (cf. the statistics to the **16 Mbit DRAM** process). Lets list a few:
  - *Etching off whole layers*. Be it some sacrificial layer after it fulfilled its purpose, the photo resist, or simply all the **CVD** layers or thermal oxides which are automatically deposited on the wafer backside, too - they all must come off eventually and this is best done by wet chemistry.
  - Etching *coarse structures*, e.g. the opening in some protective layers to the large **Al** pads which are necessary for attaching a wire to the outside world.
  - Etching off unwanted *native oxide* on all **Si** or poly-**Si** layers that were exposed to air for more than about **10 min**.
  - All *cleaning steps* may be considered to be an extreme form of chemical etching. Etching off about **1,8 nm** of native oxide might be considered cleaning, and a cleaning step where nothing is changed at the surface, simply has no effect.
- While these are not the exciting process modules, experienced process engineers know that this is where trouble lurks. Many factories have suffered large losses because the yield was down - due to some problem with wet chemistry.
- A totally new field, just making it into production for some special applications, is **electrochemical etching**. A few amazing (and not yet well understood) things can be done that way; the link provides some samples.