Problem 1.3: Material Property Treasure Hunt

This problem has two goals. The first is to encourage you to learn to use the library to find real information. The second is to gather information that will be shared with the class for use in the design projects.

You will be given the name of a microelectronic material, and a general description of how that material is to be formed or deposited. Your job is to go into the literature and find values for as many of the following room-temperature properties of that material as you can. Note that because these are thin-film materials, handbook bulk values will only be an approximate starting point. It will be necessary to consult the published literature to find real values appropriate to microelectronic materials as actually deposited in realistic processes.

Table 1: LIST OF MATERIAL PROPERTIES

Mass density
Young's modulus and Poisson ratio (or stiffness constants, if crystalline)
Tensile strength, fracture strength, or other fracture-related quantity
The residual stress if deposited on a silicon wafer
Specific heat
Thermal conductivity
Dielectric constant
Index of refraction (at some wavelength in the visible)
Electrical conductivity (or a range of conductivities)
Magnetic permeability
Piezoresistivity (if a conductor)
Piezoelectricity (in a suitable insulator)
A method for wet etching
A method for plasma etching
Adhesion to silicon dioxide (qualitative data acceptable)

Note that you are being asked to find some value, not necessarily the "best" value based on a critical reading of the literature, which is a vastly harder job. Of course, if you were really designing a part based on this material, you would be very concerned that the values you use are "right," within some tolerance, and you would need to think about test structures with which to verify those values.

You should submit your results, supported by citations of your sources in the form of a bibliography. Use the format in IEEE journal publications for your bibliography (author(s), title, publication, volume, pages, year). If the only value you can find is a bulk value in a handbook, cite the handbook and the page, or, if the handbook lists its primary source, include that also.

It is possible to spend a lot of time on this, and still not find everything. Shrewd searching, for example, for review articles on the right material, can save lots of time. However, please use judgment in allocating a reasonable amount of effort, then stop, even if your list is incomplete.

(Note to Instructors: The idea here is to give each student a different material that might be used in one of your design projects, then build a shared database for all students to use during the design problems. We have done this during the Spring of 2001 as a trial; the results can be found at web.mit.edu/6.777/www/materials.html. This is unedited student homework; use at your own risk.)

Submitted by S. D. Senturia, 2/8/01