Band-Bending and Surface Charge

Advanced

- While our basic experiment of putting some surface charge on a semiconductor surface that is insulated by a (fictive) very thin featureless insulator is simple, the necessary solutions of the Poisson equation were not.
  - Special cases, centered around some basic assumptions and concommitant mathematical approximations, had to be constructed and were treated separately:
  - - Quasi-neutrality
    - Depletion
    - Inversion
    - Accumulation

    and most of them proved to be rather tedious.
  - Fortunately, given the tremendous importance of these cases for semiconductor technology, other people have looked at this problem in great detail, and here we are just looking at some major results for the general case.
- Here we put everything together again. The essential picture shows the *maximum* amount of band bending (i.e. at ***x* = 0** where we have our external surface charge) as a function of the surface charge (always proprotional to the external voltage).
  - The curve obtained from a proper solution of the complete Poisson equation must contain as parameters the *doping concentration* and the *temperature* - the Debye length in other words.
  - Here is one version, calculated for *p-type Si* with an acceptor concentration of $\mathbf{10^{15}\ cm^{-3}}$ (i.e. a typical doping concentration corresponding to a resistivity of about **1** Ω**cm**.