

Exercise:  
**Advanced solid state physics**

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**1. Charge Up effects**

**(6 P)**

A single charged 5 keV nitrogen ( $N^+$ ) beam is used to irradiate a diamond plate. The thickness of the diamond is  $200\text{ }\mu\text{m}$ . The diamond is fully isolated and glued on a metal plate at ground potential.

- 1) Calculate the collected charge at the diamond surface (in Coulomb) after implantation with a fluence of  $10^{12}$  ions /  $\text{cm}^2$ . Assume that the beam irradiates an area of  $20\text{ }\mu\text{m}$  in diameter.
- 2) Estimate the expected implantation time for a beam current of  $0,1\text{ pA}$ .
- 3) With the assumption that the impinging charge is fixed at the top of diamond surface and by using simple plate capacitor model, calculate the expected potential (in Volt) after the implantation procedure.

**2. SRIM**

**(6P)**

Install SRIM 2008 or 2011 on your computer. Simulate the expected depth of a nitrogen beam in diamond for the following energies: 1 keV, 100 keV and 1 MeV. Calculate for these 3 energies which ion fluence (ions/ $\text{cm}^2$ ) is required to graphitize the diamond, with the assumption that graphitization takes place when the critical volume density of  $5 \times 10^{21}$  vacancies /  $\text{cm}^3$  is reached.