Prof. Dr. Ullrich Pietsch **Siegen, 23.04.2019**

Dr. Ali Abboud **Return 08.05.2019**

Exercise for Solid State Physics for Nanoscience
SS 2019
Exercise sheet 2

2.1 Figure 1 shows a cube under hydrostatic deformation by uniaxial stress of $\sigma_{ij} = -p\delta_{ij}$ (hydrostatic pressure). Apply Hook´s law and show that for cubic crystals the compression module is $K = (c_{11}+2c_{12})/3$.

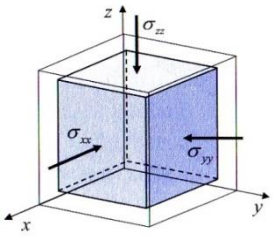

Figure 1

2.2 Assuming a cubic crystal is subjected to uniaxial stress on two opposite faces parallel to the xz-plane, define the Poisson's ratio v and show that it can be written as:

$$v = \frac{c_{12}}{c_{11} + c_{12}}$$

2.3 A cubic thin layer (epitaxial) is grown along the [001] direction onto an infinitely thick substrate. The lattice parameter of the cubic substrate is 3% smaller than the thin layer material.

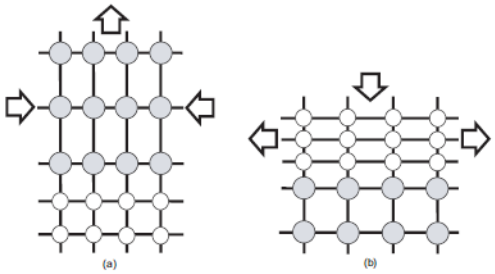

Figure 2. Schematic of layers under in-plane (a) compressive and (b) tensile strain. Layers with larger lattice constant are shown in grey.

During growth, the thin layer adopts the same lattice parameter as the substrate within the plane of growth creating biaxial compressive stress along the x and y axis (fig 2.a). Due to minimization of the stress energy, the out of plane lattice of the layer will expand. Calculate the strain along the growth axis ε_{zz} for a given in-plane strain $\varepsilon_{xx} = \varepsilon_{yy}$

2.4 Calculate the propagation velocities of longitudinal and transverse waves along the [100] direction in a cubic crystal.