(9.2) A ~100 MeV fission fragment is stopped in a plastic plate with density ~1 and an average atomic spacing of 0.25 nm. Estimate (a) the range in the plate, and (b) the ionization density (ion pairs mm^{-1}). If the ionization along the track is spread out perpendicular from the track so that 1 in 10 atoms are ionized (c) what would be the diameter of the track? From the track dimensions (d) calculate the average energy deposition to each atom within the "cylinder", and, using the relation $E=3\boldsymbol{k}T/2$, (e) estimate the average temperature within the track volume. In lack of basic data for the plastic material, use data for water.

(a)

$\mu m := 10^{-6} \cdot m$ $\quad eV := 1.60217733 \cdot 10^{-19} \cdot joule$ $\quad nm := 10^{-9} \cdot m$

(b) $Range := 0.025 \cdot mm$ (from Table 7.2) $\quad Range = 25 \cdot \mu m$

$E := 100 \cdot 10^{6} \cdot eV$ $\quad w := 38 \cdot eV$ eV/ion pair (from Table 8.1)

$LET := \frac{E}{w \cdot Range}$ $\quad LET = 1.053 \cdot 10^{5} \cdot \mu m^{-1}$ ion pairs/µm

(c)

$n := \frac{E}{w}$ ion pairs totally $\quad N := 10 \cdot n$ atoms in track

$volume := N \cdot (0.25 \cdot nm)^{3}$ $\quad length := Range$ $\quad section := \frac{volume}{length}$

$radius := \sqrt{\frac{section}{\pi}}$ $\quad diameter := 2 \cdot radius$ $\quad diameter = 4.576 \cdot nm$

(d) 1 atoms in 10 is ionized at 38 eV, thus: $E_{avg} := \frac{w}{10}$ $\quad E_{avg} = 3.8 \cdot eV$ eV/atom

(e) From this exitation energy and using $E=3\boldsymbol{k}T/2$ we get:

$k := 8.61739 \cdot 10^{-5} \cdot \frac{eV}{K}$ $\quad T := \frac{2}{3} \cdot \frac{E_{avg}}{k}$ $\quad T = 2.94 \cdot 10^{4} \cdot K$