Whereas, Figure 18.18 yields a "measured"  $\mu_{e}$  of 0.06 m<sup>2</sup>/V-s, which is higher than the "calculated" value. Therefore, the correct impurity concentration will lie somewhere between  $10^{22}$  and  $10^{23}$  m<sup>-3</sup> probably closer to the lower of these two values. At 1.3 x  $10^{22}$  m<sup>-3</sup>, both "measured" and "calculated"  $\mu_a$  values are about equal (0.095)  $m^2/V-s$ ).

It next becomes necessary to calculate the concentration of donor impurities in atom percent. This computation first requires the determination of the number of silicon atoms per cubic meter,  $N_{Si}$ , using Equation

4.2, which is as follows

$$N_{\rm Si} = \frac{N_{\rm A} \rho_{\rm Si}}{A_{\rm Si}}$$
$$= \frac{(6.023 \text{ x } 10^{23} \text{ atoms/mol})(2.33 \text{ g/cm}^3)(10^6 \text{ cm}^3/\text{m}^3)}{28.09 \text{ g/mol}}$$

$$= 5 \text{ x } 10^{28} \text{ m}^{-3}$$

(Note: in the above discussion, the density of silicon is represented by  $\rho'_{Si}$  in order to avoid confusion with resistivity, which is designated by  $\rho$ .)

The concentration of donor impurities in atom percent  $(C_d)$  is just the ratio of  $N_d$  and  $(N_d + N_{Si})$ multiplied by 100 as

$$C'_d = \frac{N_d}{N_d + N_{\rm Si}} \ge 100$$

$$= \frac{1.3 \times 10^{22} \text{ m}^{-3}}{(1.3 \times 10^{22} \text{ m}^{-3}) + (5 \times 10^{28} \text{ m}^{-3})} \times 100 = 2.6 \times 10^{-5} \text{ at\%}$$

Now, conversion to weight percent  $(C_d)$  is possible using Equation 4.7a as

$$C_d = \frac{C'_d A_d}{C'_d A_d + C'_{\text{Si}} A_{\text{Si}}} \times 100$$

where  $A_d$  and  $A_{Si}$  are the atomic weights of the donor and silicon, respectively. Thus, the concentration in weight percent will depend on the particular donor type. For example, for nitrogen

Excerpts from this work may be reproduced by instructors for distribution on a not-for-profit basis for testing or instructional purposes only to students enrolled in courses for which the textbook has been adopted. Any other reproduction or translation of this work beyond that permitted by Sections 107 or 108 of the 1976 United States Copyright Act without the permission of the copyright owner is unlawful.