Page 232, equation (4.412)

The definition of mixture free energy, (4.92), is substituted into the definition of mass fraction (4.22):

$$f = \sum_{\gamma=1}^{n} \frac{\rho_\gamma}{\rho} f_\gamma = \frac{1}{\rho} \sum_{\gamma=1}^{n} \rho_\gamma f_\gamma$$

from which follows:

$$\rho \hat{f} = \sum_{\gamma=1}^{n} \rho_\gamma \hat{f}_\gamma. \tag{1}$$

Upon substitution of (1) into the definition of chemical potential, (4.161), we obtain:

$$g_\alpha = \sum_{\gamma=1}^{n} \frac{\partial}{\partial \rho_\alpha} \left(\rho_\gamma \hat{f}_\gamma \right) = \hat{f}_\alpha + \sum_{\gamma=1}^{n} \rho_\gamma \frac{\partial \hat{f}_\gamma}{\partial \rho_\alpha} = \hat{f}_\alpha + \rho_\alpha \frac{\partial \hat{f}_\alpha}{\partial \rho_\alpha} \equiv \frac{\partial \rho_\alpha \hat{f}_\alpha}{\partial \rho_\alpha};$$

$$\alpha = 1, \ldots, n$$

which is $(4.412)_1$. The function $(4.412)_2$ follows from the fact that $f_\alpha = \hat{f}_\alpha(\rho_\alpha, T)$, cf. (4.411).