Exercise 5 to section 3.1[1]

The transformation of material volume (3.19), p. 72, can be derived from the mass balance (3.65), p. 87, considering the unchanged mass of material volume when transformed from referential to actual configuration. Try to write down this derivation before continuing reading.

Let us consider a volume element $\mathrm{d}v$ with mass $\mathrm{d}m$ in actual configuration. The corresponding volume in referential configuration is $\mathrm{d}V$ and its mass is equal also to $\mathrm{d}m$ because both volumes contain the same particles mass of which does not change. Then $\rho = \mathrm{d}m/\mathrm{d}v$ and $\rho_0 = \mathrm{d}m/\mathrm{d}V$. Substituting these expressions in (3.65), transformation (3.19) results.

[1] Based on the derivation in I. Samohýl: Irreversible Thermodynamics. Prague: University of Chemical Technology, 1998 (*in Czech*).