$\underline{A^{cc}}:$

$$\int_\Omega \underline{\underline{F}} \left(\underbrace{\underline{\underline{\underline{\underline{C}}}} \, \Delta \underline{\underline{E}}}_{\Delta \underline{\underline{S}}} \right) : \delta \underline{\underline{F}} \; dV$$

$$= \int_\Omega \underline{\underline{F}} \left[\underline{\underline{\underline{\underline{C}}}} : \left(\Delta \underline{\underline{F}}^T \underline{\underline{F}} \right) \right] : \delta \underline{\underline{F}} \; dV$$

$$= \int_\Omega F_{ol} \; C_{lmij} \; \Delta F_{ki} F_{kj} \; \delta F_{om} \; dV$$

$$= \int_{\Omega^{ref}} F_{ol} \, C_{lmij} \, \underbrace{\Delta \hat{u}_{kn} N_{n,p} J_{pi}}_{\Delta F_{ki}} F_{kj} \, \underbrace{\delta_{qo} N_{r,s} J_{sm}}_{(\delta F_{om})_{qr}} \det(J^{-1}) \, dV$$

$$= \int_{\Omega^{ref}} C_{\underset{mnop}{lmij}} \, F_{\underset{im}{ql}} \, N_{\underset{l q}{n,p}} \, J_{\underset{qo}{pi}} \, F_{\underset{kp}{kj}} \, N_{\underset{jr}{r,s}} \, J_{\underset{rn}{sm}} \, \det\left(J^{-1}\right) dV \cdot \Delta\hat{u}_{kn}$$

$$\underbrace{\phantom{= \int_{\Omega^{ref}} C_{lmij} \, F_{ql} \, N_{n,p} \, J_{pi} \, F_{kj} \, N_{r,s} \, J_{sm} \, \det\left(J^{-1}\right) dV}}_{\underset{qrkn}{A^{cc}_{ijkl}}}$$

$$A^{cc}_{ijkl} = \int_{\Omega^{ref}} C_{mnop} \, F_{im} \, N_{l,q} \, J_{kp} \, N_{j,r} \, J_{rn} \, \det\left(J^{-1}\right) dV$$

$\underline{F^{int}}:$

$$\int_\Omega \left(\underline{\underline{F}} \, \underline{\underline{S}} \right) : \delta \underline{\underline{F}} \; dV$$

$$= \int_\Omega F_{ik} S_{kj} \; \delta F_{ij} \, dV$$

$$= \int_{\Omega^{ref}} F_{ik} S_{kj} \; \underbrace{\delta_{li} N_{m,n} J_{nj}}_{(\delta F_{ij})_{lm}} \det(J^{-1}) \, dV$$

$$= \int_{\Omega^{ref}} F_{\underset{ik}{lk}} S_{\underset{kl}{kj}} \, N_{\underset{jn}{m,n}} \, J_{\underset{ml}{nj}} \det\left(J^{-1}\right) dV$$

$$\underbrace{\phantom{= \int_{\Omega^{ref}} F_{lk} S_{kj} \, N_{m,n} \, J_{nj} \det\left(J^{-1}\right) dV}}_{\underset{im}{F_{ij}}}$$

$$F^{int}_{ij} = \int_{\Omega^{ref}} F_{ik} S_{kl} \, N_{j,m} \, J_{ml} \, \det\left(J^{-1}\right) dV$$