

TABLE 9.3
Strain Tensors for Shear and Extension in Cartesian Coordinates*

Tensor	Shear in 1-Direction with Gradient in 2-Direction	Uniaxial Elongation in 3-Direction	Counterclockwise Rotation around \hat{e}_3
$\underline{\underline{F}}(t, t')$	$\begin{pmatrix} 1 & 0 & 0 \\ -\gamma & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}_{123}$	$\begin{pmatrix} e^{\frac{\epsilon}{2}} & 0 & 0 \\ 0 & e^{\frac{\epsilon}{2}} & 0 \\ 0 & 0 & e^{-\epsilon} \end{pmatrix}_{123}$	$\begin{pmatrix} \cos \psi & -\sin \psi & 0 \\ \sin \psi & \cos \psi & 0 \\ 0 & 0 & 1 \end{pmatrix}_{123}$
$\underline{\underline{F}}^{-1}(t', t)$	$\begin{pmatrix} 1 & 0 & 0 \\ \gamma & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}_{123}$	$\begin{pmatrix} e^{-\frac{\epsilon}{2}} & 0 & 0 \\ 0 & e^{-\frac{\epsilon}{2}} & 0 \\ 0 & 0 & e^{\epsilon} \end{pmatrix}_{123}$	$\begin{pmatrix} \cos \psi & \sin \psi & 0 \\ -\sin \psi & \cos \psi & 0 \\ 0 & 0 & 1 \end{pmatrix}_{123}$
$\underline{\underline{C}}(t, t')$	$\begin{pmatrix} 1 & -\gamma & 0 \\ -\gamma & 1 + \gamma^2 & 0 \\ 0 & 0 & 1 \end{pmatrix}_{123}$	$\begin{pmatrix} e^{\epsilon} & 0 & 0 \\ 0 & e^{\epsilon} & 0 \\ 0 & 0 & e^{-2\epsilon} \end{pmatrix}_{123}$	$\underline{\underline{I}}$
$\underline{\underline{C}}^{-1}(t', t)$	$\begin{pmatrix} 1 + \gamma^2 & \gamma & 0 \\ \gamma & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}_{123}$	$\begin{pmatrix} e^{-\epsilon} & 0 & 0 \\ 0 & e^{-\epsilon} & 0 \\ 0 & 0 & e^{2\epsilon} \end{pmatrix}_{123}$	$\underline{\underline{I}}$
$\underline{\underline{\gamma}}^{[0]}(t, t')$	$\begin{pmatrix} 0 & -\gamma & 0 \\ -\gamma & \gamma^2 & 0 \\ 0 & 0 & 1 \end{pmatrix}_{123}$	$\begin{pmatrix} e^{\epsilon} - 1 & 0 & 0 \\ 0 & e^{\epsilon} - 1 & 0 \\ 0 & 0 & e^{-2\epsilon} - 1 \end{pmatrix}_{123}$	$\underline{\underline{0}}$
$\underline{\underline{\gamma}}_{[0]}(t, t')$	$\begin{pmatrix} -\gamma^2 & \gamma & 0 \\ \gamma & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}_{123}$	$\begin{pmatrix} e^{-\epsilon} - 1 & 0 & 0 \\ 0 & e^{-\epsilon} - 1 & 0 \\ 0 & 0 & e^{2\epsilon} - 1 \end{pmatrix}_{123}$	$\underline{\underline{0}}$

*For shear flows $\gamma = \gamma(t', t) = \int_{t'}^t \dot{\gamma}(t'') dt'' = \int_{t'}^t \dot{\gamma}_{21}(t'') dt''$ and for elongational flows $\epsilon = \epsilon(t', t) = \int_{t'}^t \dot{\epsilon}(t'') dt''$.
 The angle ψ is the angle from $\underline{r}(t) = \underline{r}$ to $\underline{r}(t') = \underline{r}'$ in counterclockwise rotation around the \hat{e}_3 -axis.