A constitutive relationship between slip rate $\dot{\gamma}$ and shear stress $\tau_{\text{eff}}$ is constructed by combining individual flow rules (1) of four different interaction mechanisms, Fig.4.

\begin{equation}
\dot{\gamma}_{ij} = \rho_{\text{m}}(\tau_{\text{th}}, \dot{\gamma}_{ij})\cdot b\cdot v(\tau_{\text{th}}, \dot{\gamma}_{ij}, T)
\end{equation}

Results

For an AlCu alloy with an average particle size of 12μm and volume fraction of 1.2%, the model predicts (Fig.5):

- increased strength due to particles
- larger slip rates for screw dislocations than edge type
- larger slip rates at higher temperatures
- increased slip rate of edge dislocations due to influence of climb, which vanishes at larger stresses
- almost no effect of climb on slip rate of screw dislocations

Conclusion

The new strain gradient crystal plasticity model is promising as being complementary to the multiphysical simulations of RF-MEMS by quantitatively describing the time and scale dependent material behavior.