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Simulation of Abrasive Machining Using Molecular Dynamics

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Introduction
The development of ultra-precision processes which can achieve excellent surface finish and tolerance at nanometre level is now a critical requirement for many applications in medical, electronics and energy industry. Presently, it is very difficult to observe the diverse microscopic physical phenomena occurring in nanometric machining through experiments. The use of Molecular Dynamics (MD) simulation has proved to be an effective tool for the prediction and the analysis of these processes at the nanometre scale. The complexity and the cost of experimental investigation have made this approach even more suitable as simulation results sometimes point interesting directions for experimentation.

Objective
To model abrasive machining using the Molecular Dynamics (MD)

Methodology
The outline of the MD simulation is as follows:

- Choose the model, choose an appropriate interatomic potential and the means of calculating the equations of motion
- Initialize the model
- Relax the model from its initial state to its dynamically equilibrium condition
- Run the simulation and analyze the results

Equations

Newton’s Law

\[ F_i = -\frac{\partial}{\partial r_i}V(r_1, \ldots, r_N) \]  

……(1)

L-J Potentials

\[ V_{ij} = 4\varepsilon \left[ \left( \frac{\sigma}{r} \right)^{12} - \left( \frac{\sigma}{r} \right)^{6} \right] \]  

……(2)

Basic Velvet Algorithm

\[ r(t + \Delta t) = 2r(t) - r(t - \Delta t) + a(t)\Delta t^2 \]  

……(3)

Conclusions
The MD simulation provides details of the abrasive machining at the atomistic level.