11:40–210B

On two minimalist models for moving/evaporating contact lines without slip on a macroscopically dry homogeneous substrate

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We consider two minimalist models allowing self-consistent analyses of contact-line microstructures in the hydrodynamic framework, without any slip length nor extended precursor film model. The apparent contact angles induced by motion and/or evaporation are discussed as part of the analysis. Even though a disjoining pressure (here positive and of the usual inverse cubic type) is necessary in the first model, inspired by de Gennes and collaborators, we limit our consideration to microstructures with truncated precursor films, i.e., starting on a macroscopically bare solid. Viscous and thermal divergences still show up here but turn out to be integrable, hence in principle acceptable. The second model does not formally require any disjoining pressure, but rather fully relies on phase change (evaporation/condensation) including Kelvin effect, for a liquid in contact with its pure vapour. In contrast with the first approach, the behaviour at the microstructure tip is here fully regular.

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FS09: Mechanics of materials processing
09:20–10:40, Friday, 24 August
Timothy J. Burns, USA, Chair
Francisco Chinesta, Spain, Chair
Room: 211

09:20–211

A simple nonlinear cutting model for the quick qualitative description of chip formation

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We set up a simple cutting model for the qualitative description of the process. Our basic nonlinear thermo-mechanical model comprises four ordinary differential equations. While this model captures the most important characteristics of chip formation, the system of equations is simple enough to be examined by bifurcation analysis. Thus, the effects of parameter changes can be predicted. This model can be extended simply to the description of the effects of varying cutting speed and varying depth of cut. Although the regenerative effects are not considered yet, the model can be coupled with regenerative models, too. Since the number of parameters is relatively low, we believe that our simple– - but experimentally validated—model can be used for the quick overview of the cutting process.

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09:40–211

Three-dimensional transient numerical simulation of gaussian laser beam drilling process

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A solid/liquid/gas three-phase numerical model for laser drilling with Gaussian laser beam is presented by considering material evaporation, molten liquid ejection caused recoil pressure and beam divergence near the focus. Level set method is adopted to capture the liquid/vapour (L/V) interface as the hole boundary. Temperature field and hole profile evolution are investigated with different defocus distance. The simulated hole profile is compared with the experimental ones to verify the model's validity. During drilling process, temperature in the hole bottom is found to be much higher than the boiling point of material due to the highly superheated of L/V interface which leads to generation of recoil pressure. The defocusing position relative to material surface is shown to affect the hole profile strongly, shorter negative defocus distance from laser beam focus to workpiece surface can reduce the inlet diameter and increase the depth of the hole.

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10:00–211

Fluid flow and its driving forces in laser dissimilar welding of stainless steel and nickel

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Laser spot welding of stainless steel-nickel dissimilar couple has been studied experimentally and numerically. A three-dimensional heat and mass transfer model is used to simulate the welding process, based on the solution of the equations of mass, momentum, energy conservation and solute transport in weld pool. Dimensional analysis reveals that the fluid flow is mainly driven by Marangoni convection and to a much less extent by the buoyancy force. Marangoni stresses due to temperature gradient and concentration gradient have comparable magnitudes during the initial stage of melting but have different trends as weld pool develops. Calculated weld pool dimensions when fluid flow is considered agree better with corresponding experimental results.

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10:20–211

Towards an integrated approach of production systems

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