NANO HIGHLIGHT
Deformation Mechanisms and Manufacturing of Nanostructured Materials Processed by Severe Plastic Deformation (SPD)

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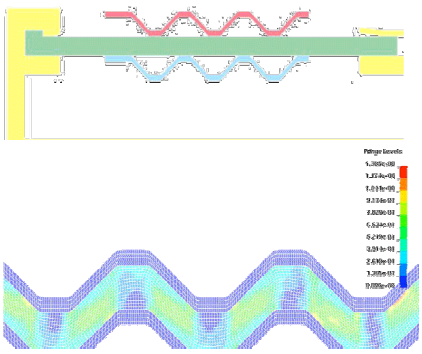
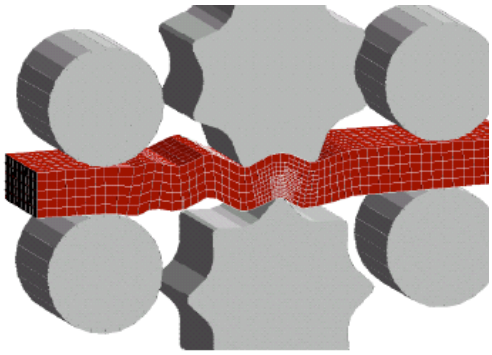
Manufacturing Science: Figure 1 shows a finite element simulation one of the processes we are developing, namely that of repetitive shear and straightening. Simply put, this process involves subjecting a bulk material to combinations of very intense plastic shear followed by straightening; a key to successful design of such processes involves, *inter alia*, maintaining high degrees of hydrostatic pressure during the shear strain process. This, in turn, involves design for tooling that imparts optimal combinations of shear and hydrostatic compression. Still another design challenge is to ensure that the deformation is uniform. Our approach makes use of a computational simulation of the entire synthesis process for the purpose of optimization, the results of which are used to design tooling for what is a kind of "rolling process". All aspects of the process are simulated and optimization algorithms are designed to enable a rational approach to optimizing, *inter alia*, the shape of the "gear like" tooling, the temperatures used, deformation rates, and post processing involved with straightening. We have already built a first generation RCS rolling mill and are in the process of evaluating its performance *vis-à-vis* these design simulations. Our ultimate plans involve the construction of a miniature manufacturing facility to demonstrate the viability of the process.





A specific purpose of such simulations is the optimization of designs for tooling such as shown in Figure 2. The simulations therein and as illustrated in Figure 1 are meant to fully optimize the designs to achieve, *inter alia*, maximum uniform shear, but with high levels of hydrostatic compression.

We have built a first generation RCS processing unit and are currently evaluating its performance.

For further information about this project email rasaro@ucsd.edu. Also, see: http://hogwarts.ucsd.edu/~nirt**.**

References :

[1] Asaro, R. J., Krysl, P. and Kad, B., "Deformation Mechanism Transitions in Nano-Scale FCC Metals", to appear in Phil. Mag. Letters
[2] Asaro, R. J., Krysl, P. and Kad, B., Transitions in Deformation Modes in FCC Nanocrystalline Metals, in preparation for publication.
[3] Yuntain Zhu, Asaro, R.J. *et al.*, "Development of Repetitive Corrugation and Straightening", in press, Materials Science and Engineering, January 2003.