

Study on efficiency of computational domain decomposition in parallel cellular automata static recrystallization model based on MPI standard.

M. Sitko, L. Madej

AGH University of Science and Technology
Faculty of Metals Engineering and Industrial Computer Science
30 Mickiewicza Av. 30-059 Krakow, Poland
e-mail: msitko@agh.edu.pl, web page: www.msm.agh.edu.pl

ABSTRACT

Sophisticated properties of final metal products are related to complicated thermo-mechanical treatment operations. There are two important phenomena, that allow controlling microstructure evolution during hot deformation conditions: recovery and recrystallization, respectively [1]. Numerical modelling of microstructure evolution is recently a very important part of development of innovative metal forming operations and new materials. Modern material models are often based on the Cellular Automata (CA) or Monte Carlo (MC) approaches because these discrete techniques take into account not only kinetics of the process but also microstructure morphology changes [2,3]. However, major weakness of these methods is computational time. Especially in 3D times are an enormous obstacle for practical applications. One of the method, investigated within the work, to reduce computation time is application of code parallelization schemes. When parallel execution of the CA algorithm is discussed, firstly problem related with efficient division of the CA space should be addressed.

The master-slave approach and MPI standards are used in the present work to parallelize the CA static recrystallization code. Concept of one of the investigated space division schemes based on equal rectangular computational domains, which are distributed between computing nodes, is presented in Figure. 1. In the approach only master node stores information on entire CA space, however at the same time performs computation only on the part of this space. Within the paper different computational domain decompositions were developed and tested. Particular attention was focused on influence of sequential part, communication time, memory and cache usage on computing time. After that, analysis of efficiency and scalability was performed to evaluate capabilities and limitations of proposed approaches.

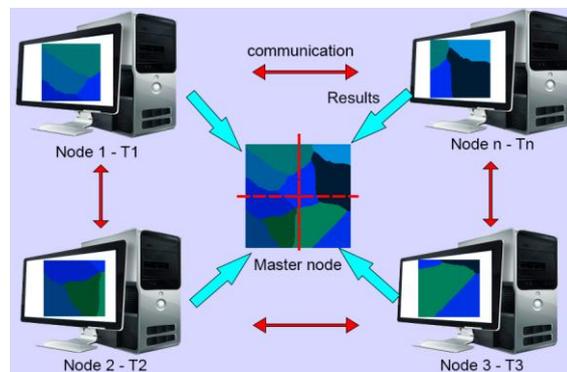


Figure 1. MPI space division concept

REFERENCES

- [1] M.J. Humphreys, M. Hatherly, *Recrystallization and related annealing phenomena*, second ed. Elsevier, Oxford, (2004).
- [2] L. Sieradzki, L. Madej, A perceptive comparison of the cellular automata and Monte Carlo techniques in application to static recrystallization modeling in polycrystalline materials, *Comp. Mat. Sci.*, 67, 156–173, (2013).
- [3] L. Madej, L. Rauch, K. Perzynski, P. Cybulka, Digital Material Representation as an efficient tool for strain inhomogeneities analysis at the micro scale level, *Arch. Civ. Mech. Eng.*, 11, 661–679, (2011).

Acknowledgements. Financial assistance of the NCN project no 2016/21/N/ST8/00194 is acknowledged.