1. Project name – PSI (plasma surface interaction)

2. Team members.

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Task allocation:

Dasha Dvinskih – find sources, prepare results and making the presentation

Ignatov Alexey –state the problem, approximation scheme and implementation the solver

Nikolay Vaulin – implementation of paralalization and multigrid method

Lenar Siraziev – validation, evaluation of performance

3. Background.

First of all the problem of high-accurate computing the PSI is up to date and takes place in obtaining the properties of plasma where experimentally it is not possible due to small area and high gradient of parameters (plasmotron nozzle channels, near-surfaces of electrodes, Tokamaks, etc). From the numerical side there are lot of problems of computing different parameters like collision integral and the solution of system of nonlinear equations. For instance in 1D we will obtain the set of non-linear equations that will be reduced to linear with block diagonal matrix, each block of it has nxn dimention where n- quantity of particles that are considered in our model.

Linear algebra helps to obtain the solution of set of PDE that will be stated.

4. Problem formulation

There is the non-equilibrium Ar plasma with zero velocity relatively the surface of solid Fe metal. The j current goes through plasma and it is the source of energy that are absorbed by the Ar gas in order to be ionized.

The model of behaviors of such plasma could be described by 1D set of transport equations that has all necessary physical phenomena. The goal is to obtain the stationary solution of PSI.

5. Data

Database is presented in references.

6. Related work

It has been done the 3component PSI in plasmatron nozzle channel. The evaporation phenomenon is considered in models without including nonequilibrium state of the plasma.

7. Scope

Phases in our work will be:

1. Read articles.
2. State the problem
3. Build proper model
4. Make it dimensionless
5. Find the database of properties of substance
6. Choose the numerical method
7. Set the nonlinear grid
8. Approximate the set of fundamental equations
9. Write the solver
10. Implement multigrid method
11. Parallelize program
12. Evaluate performance
13. Obtain and validate the results
14. Prepare results
15. Make presentation
16. Underline the main problem of solver and figure out the probable expand of current problem

By the end of the project we will expect to obtain the optimal physical model, fast solver, analysis of its performance, macroparameters of substance and its validation.

8. Evaluation

There will be evaluation of wall-clock time of performance using stated model and evaluation of parallelization of code. In addition it will be compared the Matrix sweep (matrix cyclic reduction for parallel computation) for obtaining the solution and already implemented methods in program shell.

9. References

There are a lot of references that are necessary for this problem. The most important for current work are:

1. *Meier E.T., Shumlak U.* A general nonlinear fluid model for reacting plasma-neutral mixtures // Physics of Plasma. – 2012. – **19**. – 072508 (11 p).
2. *Benilov M.S.* The ion flux from a thermal plasma to a surface // J. Phys. D: Appl. Phys. – 1995. – **28**. – P. 286-294.
3. *Benilov M.S., Marotta A.* A model of the cathode region of atmospheric pressure arcs // Ibid. – 1995. – **28.** – P. 1869-1882.
4. *Almeida M.S., Benilov M.S., Naidis G.V.* Simulation of the layer of non-equilibrium ionization in a high-pressure argon plasma with multiply-charged ions // Ibid. – 2000. –**33**. – P. 960–967.
5. *Almeida N.A., Benilov M.S., Naidis G.V.* Unified modelling of near-cathode plasma layers in high-pressure arc discharges // Ibid. – 2008. – **41**. – 245201 (26 p).
6. *Low-temperature* plasma / V.S. Engelsht, V.Ts. Gurovich, G.A. Desyatkov, et al. – Novosibirsk: Nauka, 1990. – V. 1. Theory of electric arc column. – 376 p.
7. *A two-dimensional* nonequilibrium model of cascaded arc plasma flows / J.J. Beulens, D. Milojevic, D.C. Schram, et al. // Phys. Fluids B. – 1991. – **3** (9). – P. 2548-2557.
8. *Zhadanov V.M.* Transfer phenomena in multi-component plasma. – Moscow: Energoizdat, 1982. – 176 c.