

A 3D model calculating sputtering and depositing processes under Electric Propulsion thruster testing in a vacuum chamber.

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Abstract: When an Electric Propulsion thruster is tested in a vacuum chamber, a plum of accelerated ions interacts with the wall. In this case vacuum chamber walls are spattered and some part of the spattered particles come back to the thruster creating a cover on their surfaces. Under real conditions there is no such covering. The tasks simulating the sputtering process and the deposition process of spattered material from the object being close to the thruster under real conditions of its operation in space have already been solved and respective algorithms have already been written. The authors developed 3D model simulating sputtering-depositing processes occurring in the vacuum chamber. The software permits to estimate how vacuum chamber geometry influences the amount of depositing material. In calculating the real vacuum chambers it was discovered that maximum concentration of the material spattered from the chamber's walls is in the area of the thruster location, this is very undesirable and we had not suspected this phenomenon. One of the aims of this work is to create the code permitting user to import geometry from CAD systems (Compas, SolidWorks, CATIA, Pro/E and so on). In order to solve this task a library CADEXchanges.dll was written, which is able to write point arrays of triangles describing the faces with normals in the corresponding points in a proper way. Then these arrays are automatically exported into the software ISP-2000 and a corresponding arrangement tree is built.

I. Introduction

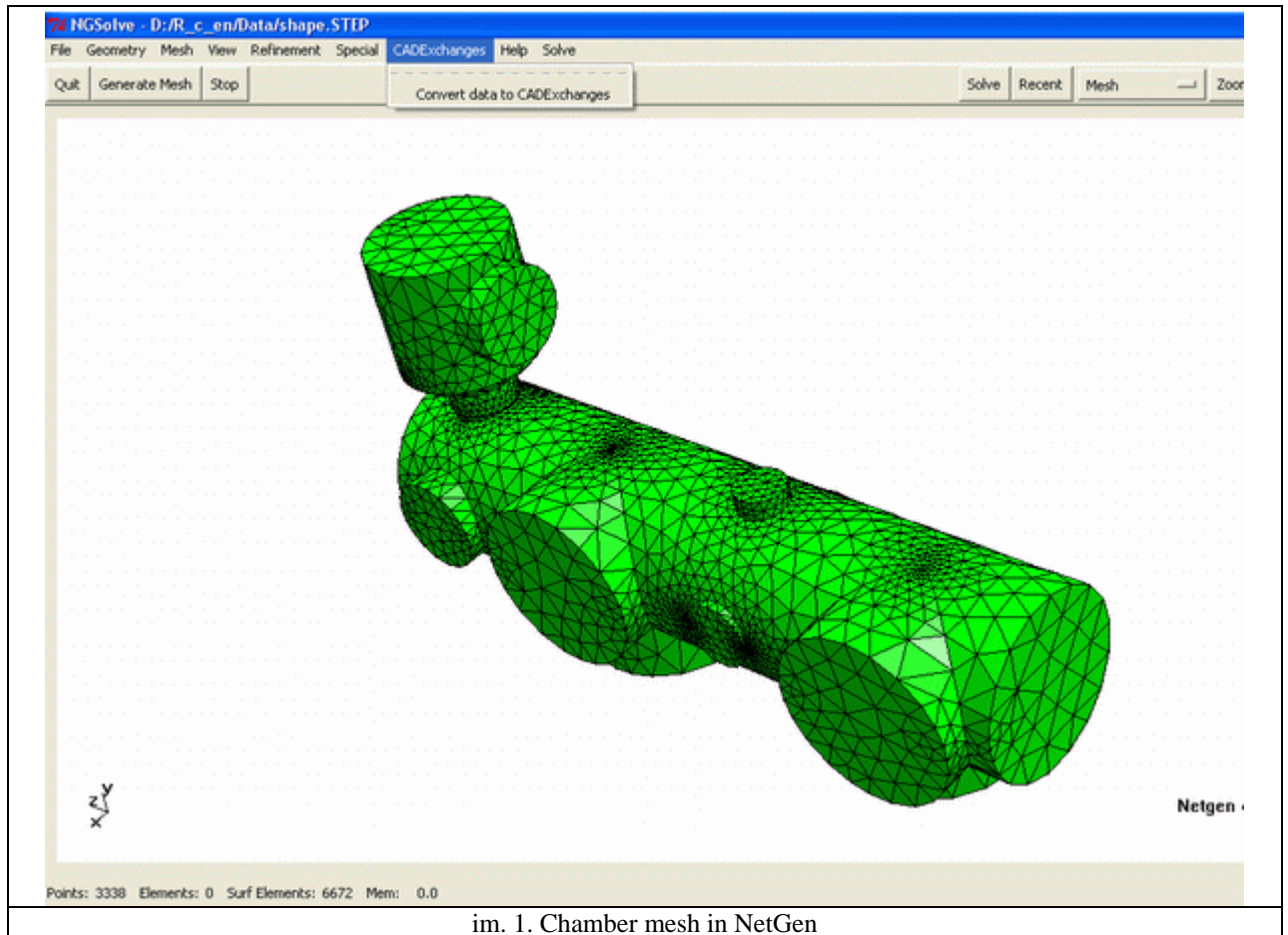
When the Hall thruster operates in a vacuum chamber, the accelerated ions interact with the wall of the chamber. The material of the chamber's wall spattered and part of the spattered particles came back in the thruster, initiating processes which wouldn't occur in space.

The problems of sputtering and deposition have already been solved for space objects and goals. The algorithms for them has already been written by Nadiradze A.B.[11]. But his program didn't have capacity of importing geometry from CAD systems (SolidWorks, CATIA, Pro/E etc.) However our program works with geometry imported from CAD systems with the help of step and iges files.

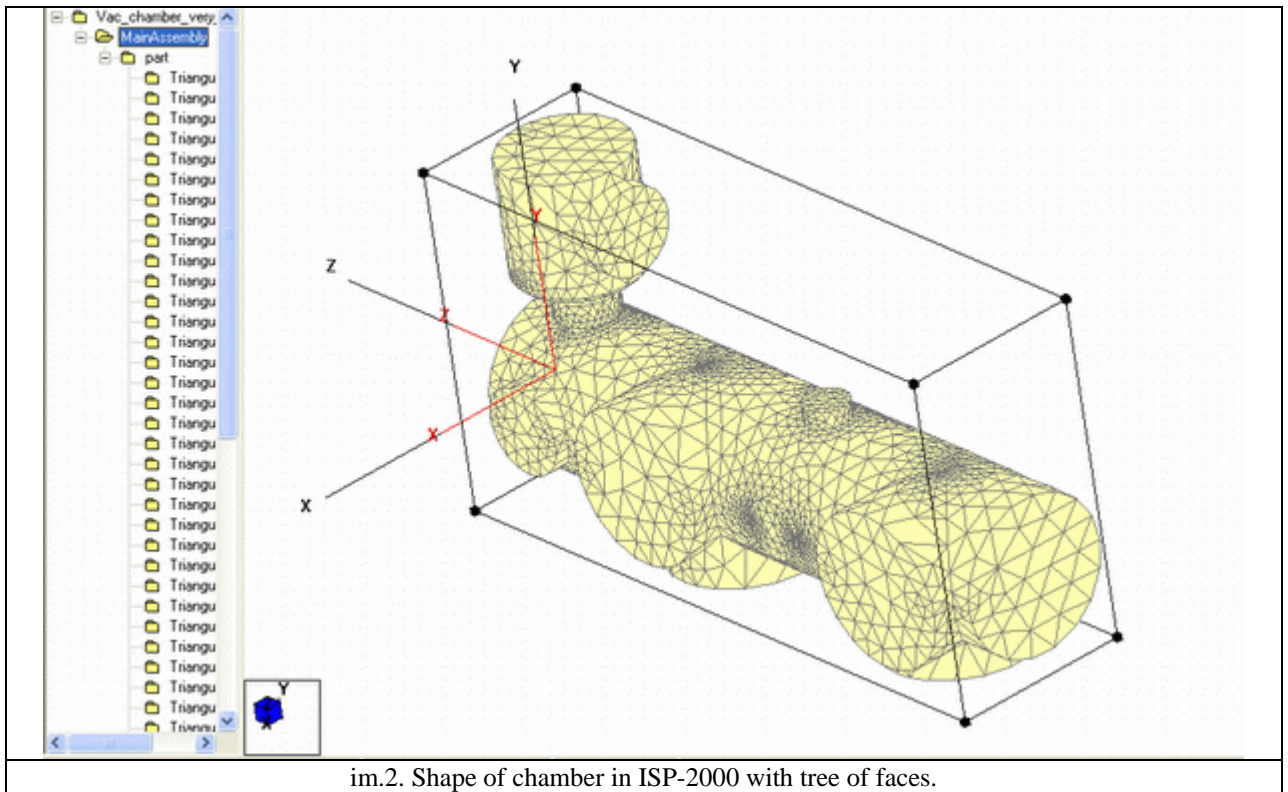
For solving this problem we wrote the CADEXchanges library. This library can write the arrays of triangles which describe the faces of shape and normals in the vertex of triangles. Then these arrays automatically are exported in the ISP program (developed by Nadiradze A.B.) with the building of a corresponding tree of assembly shape.

II. General Guidelines

Shown is the example of triangulation in Netgen and its exportation in the ISP:

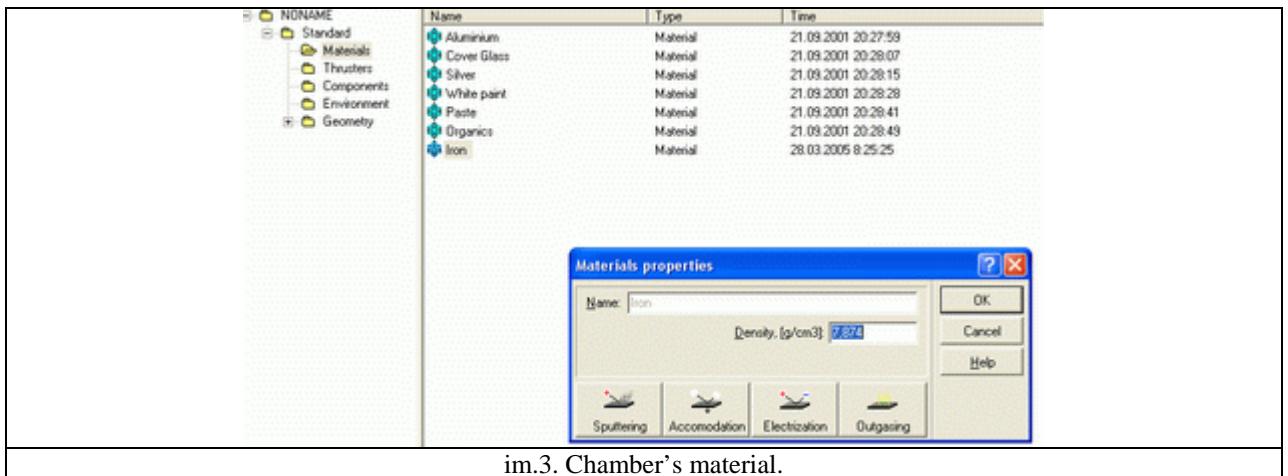


NETGEN is an automatic mesh generation tool of two and three dimensions. Netgen is an open source under the conditions of the LGPL. It comes as stand alone program with graphical user interface, or as C++ library to be linked into another application.

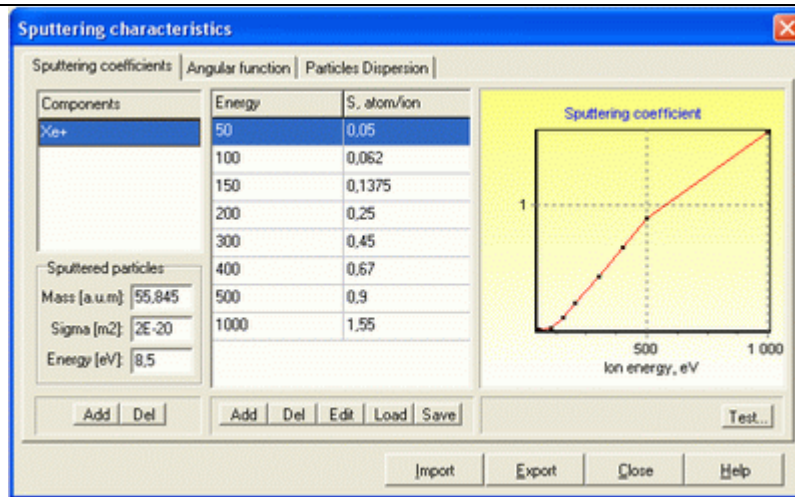


im.2. Shape of chamber in ISP-2000 with tree of faces.

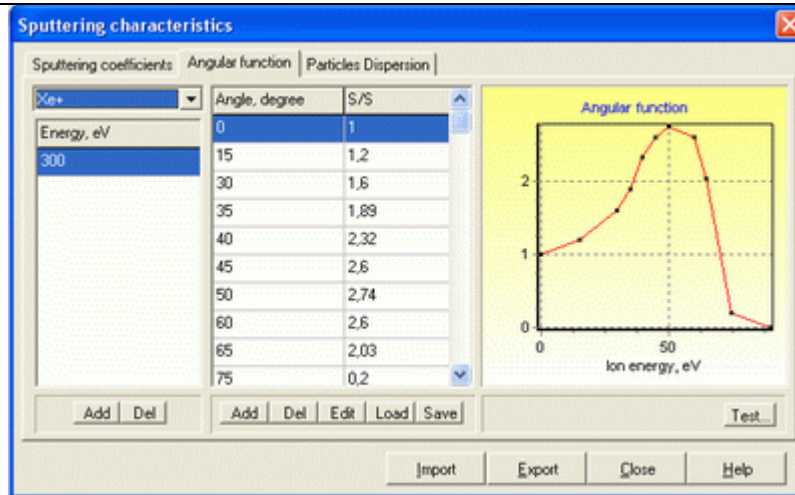
For the proper solving of sputtering goals, we must give the characteristics of the chamber wall material:



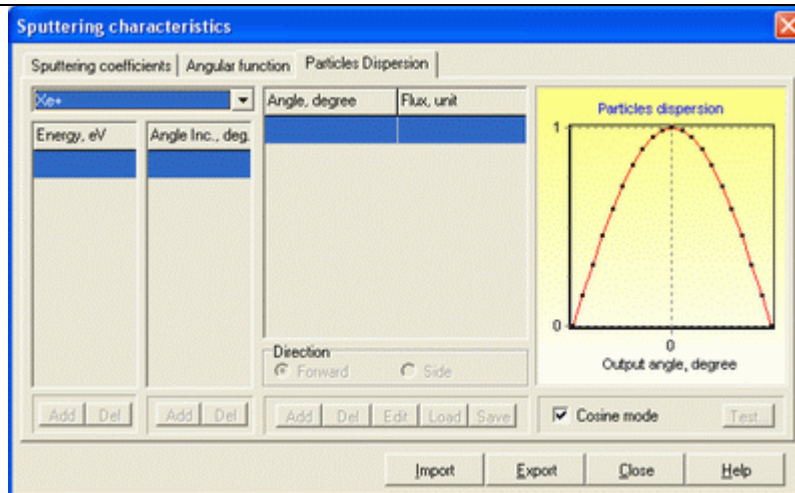
im.3. Chamber's material.



im.4. Sputtering coefficient.

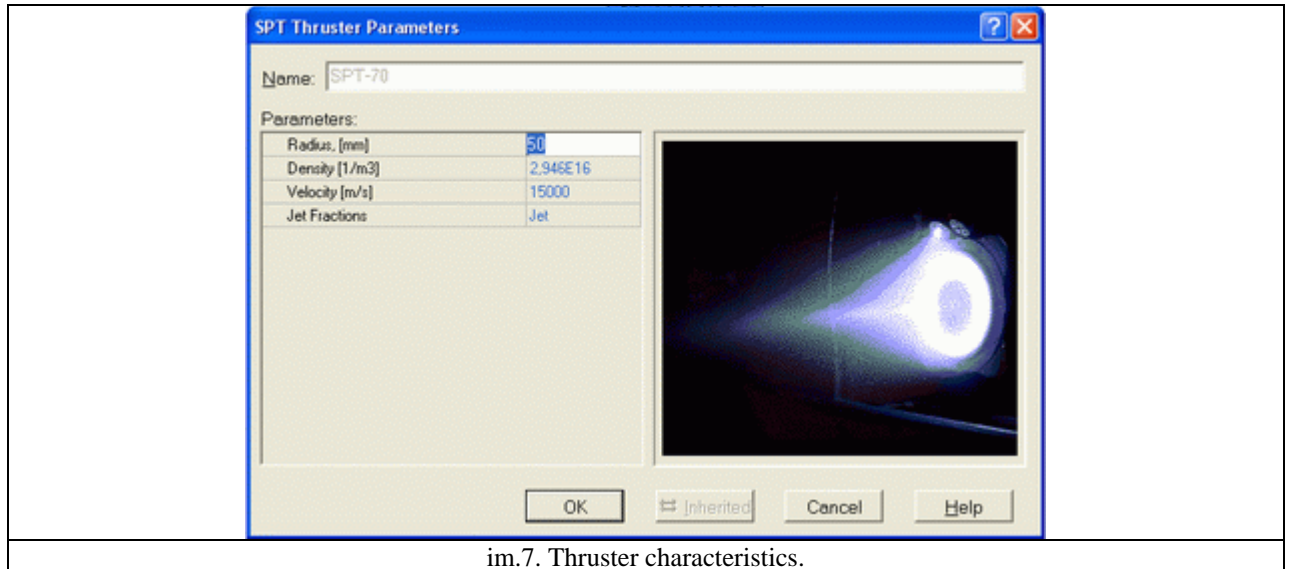


im.5. Angle distribution of sputtered particles



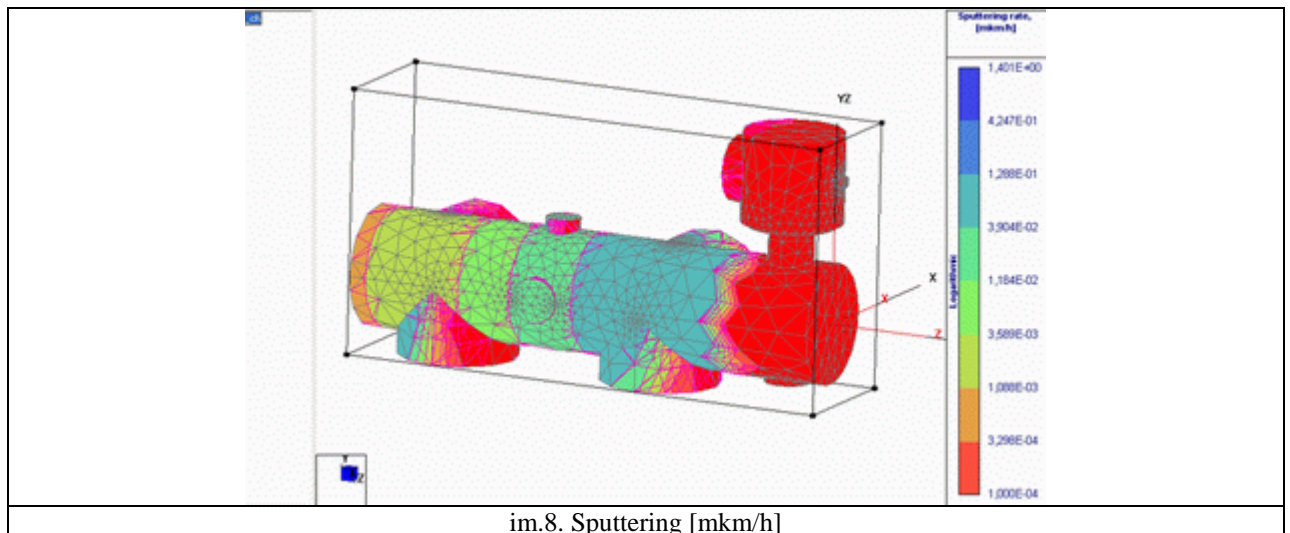
im.6. Particle dispersion.

Characteristics of the thruster:



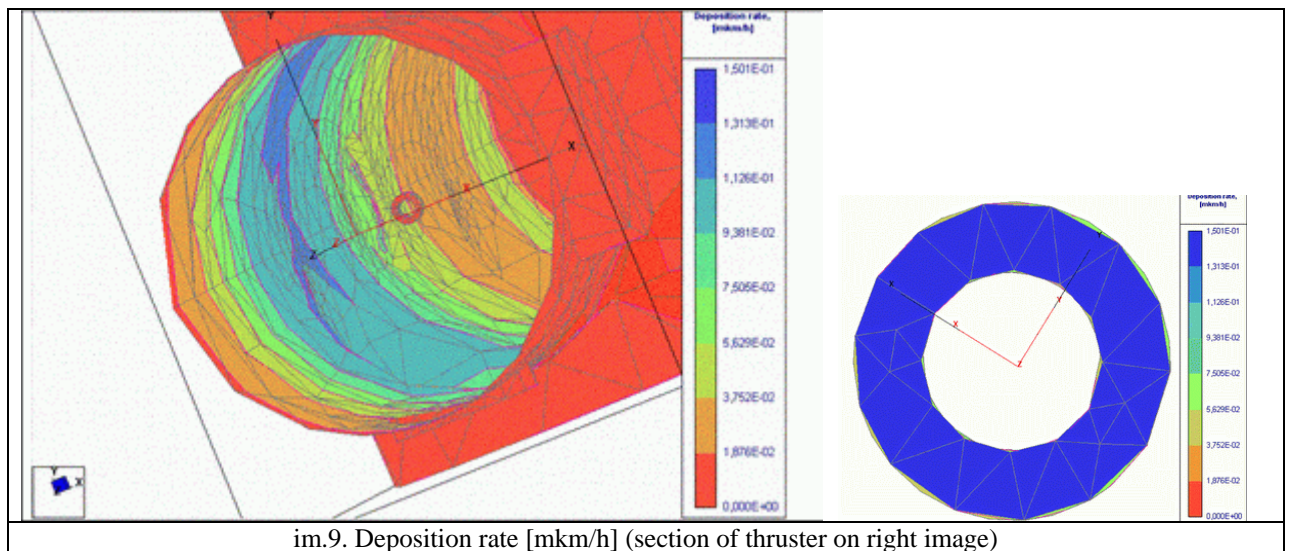
im.7. Thruster characteristics.

The results of sputtering calculation:



im.8. Sputtering [mkm/h]

Visualization of the deposition of sputtered particles on the chamber walls and on the thruster face:



im.9. Deposition rate [mkm/h] (section of thruster on right image)

III. Conclusion

To create the mesh we need only a step file of the shape of the chamber, which could be made using almost any CAD system. In calculating the real vacuum chambers, it was discovered that maximum concentration of the material spattered from the chamber's walls is in the area of the thruster location, which is very undesirable and we had not suspected this phenomenon. The prices on our calculations, validation, components used in developer loop, and community information are on <http://www.epcmo.com>

Acknowledgments

Nadiradze A.B. for algorithms of ISP-2000 package.

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Electronic Publications

- ¹² <http://www.epcmo.com>

Computer Software

- ¹³ MSDN 2003.