# My current research status

David Pugal

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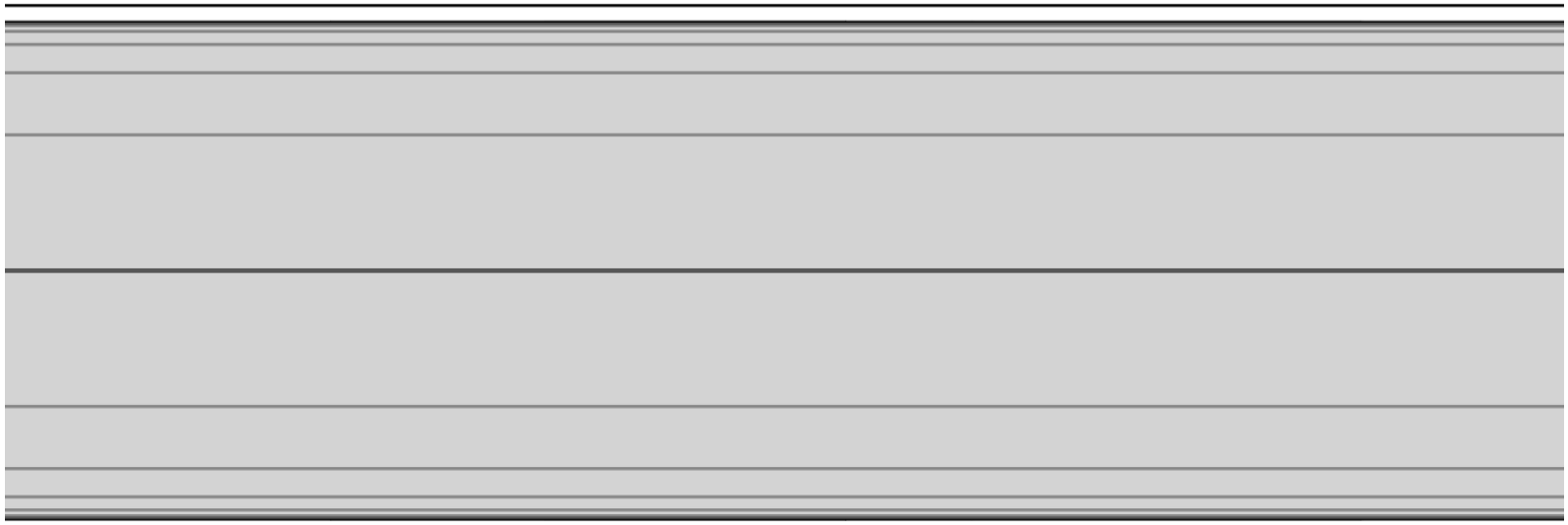
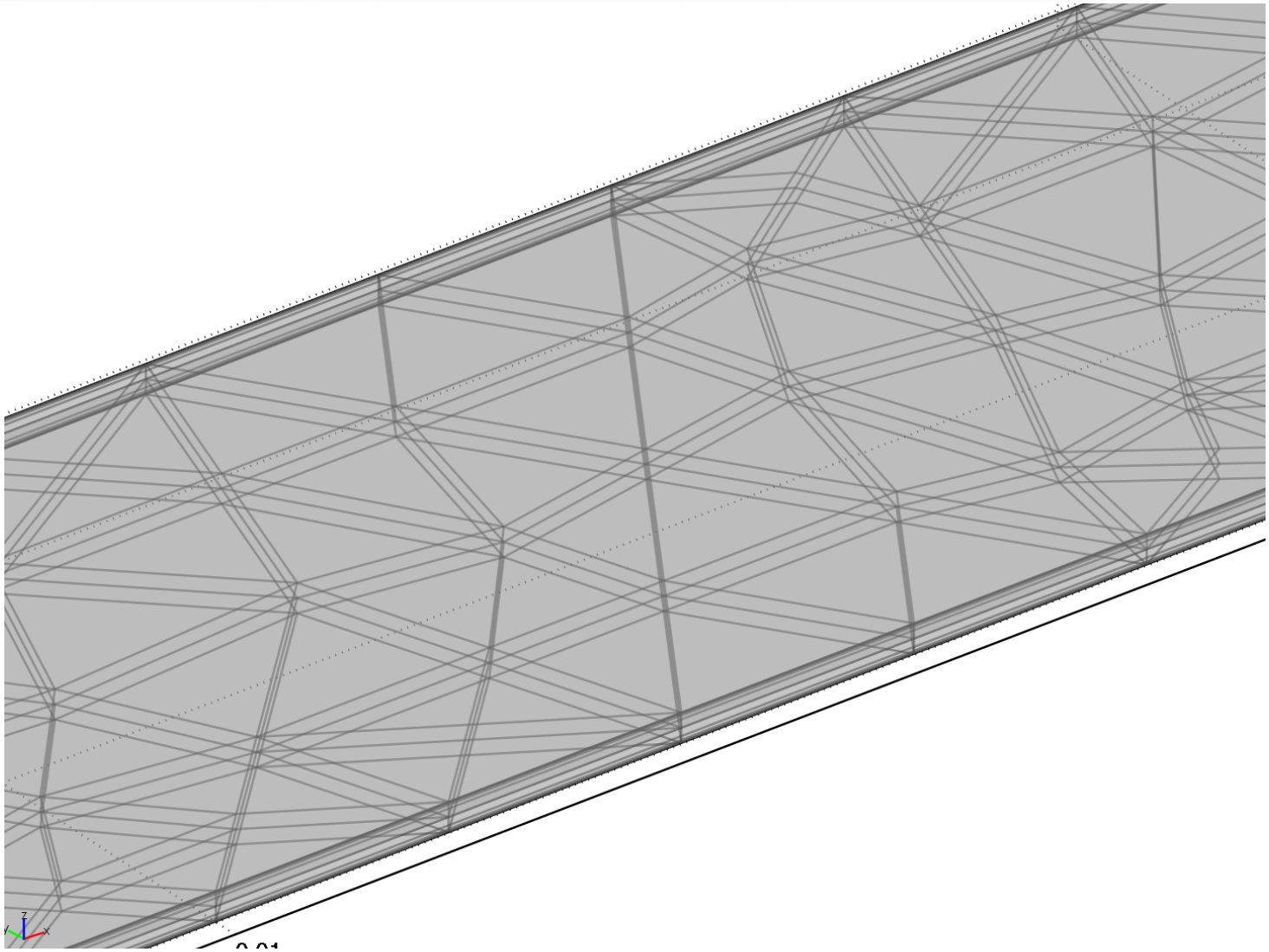
# New things

- I have been working on the 3D model of an IPMC
  - Not that 3D would make any big difference. Just it would be nice to add the result to the article.
  - Challenges
    a. Meshing – the mesh must be chosen really well – otherwise the calcuation would take either forever... or kill the computer/Windows
    b. The solution I have found, is mapped/swept meshing.
       - I have got a solution, for „only“ 80 000 degrees of freedom.
       - Still, some constants need to be changed – takes time, because solving 3D takes time (I still haven't had chance to upgrade memory in server).
    c. The one must think really carefully before adding features to 3D model – the level of complexity is about order of magnitude higher than for 2D model.

# 3D mesh – cross section



# 3D mesh – top and sides view



# Electrocemistry

- I tried to make the electrochemistry equations look better.
  - Now the equation, describing the voltage (main equation of affecting frequecy of oscillations) looks like that:

$$\dot{U} = J_{thres} + J_r \cdot sign(\Delta C) - A \cdot (k_1 \cdot (1 - \dot{C_{CO}} - \dot{C_{OH}}) + k_4 \cdot \dot{C_{CO}} - \dot{C_{OH}})$$

  - So I got rid of the double layer. Though there is an article saying that HCHO concentration in double layer is important, the calclualtions in this article do not work. So in this model, we assume the ~ constant concentration of HCHO in double layer – gives reasonable results.
  - Playing with variabes J_r and dC from the equation, we can change the output frequency.

# New developements

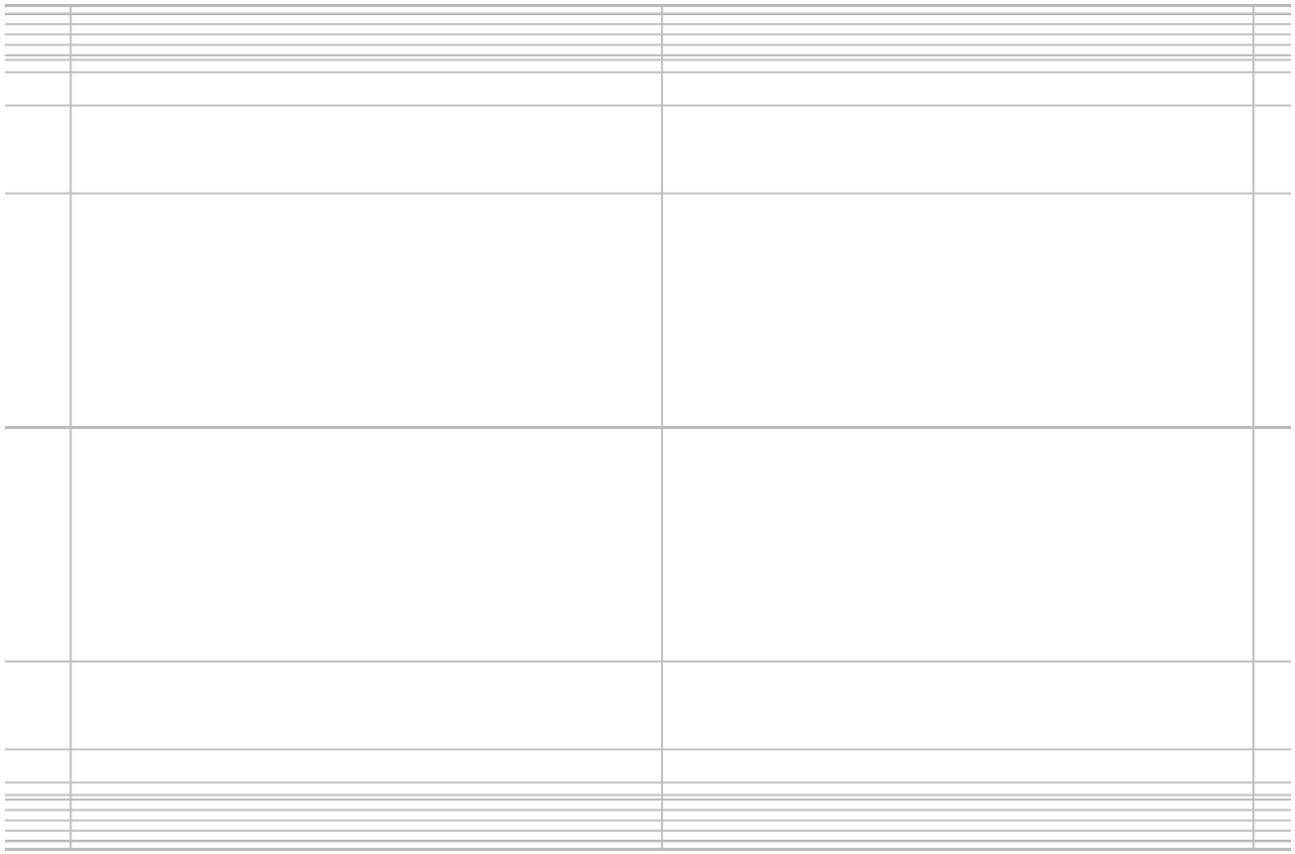
- There is an article:

  *„Finite element analysis of two-dimensional electrochemical-mechanical response of ionic conducting polymer-metal composite beams“*

  - They had used term „water viscocity“ in their calculations. I tried to include that into my model also... and...
    a. Basically I reached to the conclusion, that mobility, which is defined as $\mu = \frac{D}{R \cdot T}$ , includes the water viscocity term.
    b. The water should be considered separately only for the case, where the back relaxation is important – in our model, it is really not.
       - So no need to consider water diffusion and we could use measured/obtained **D** value in the equations.

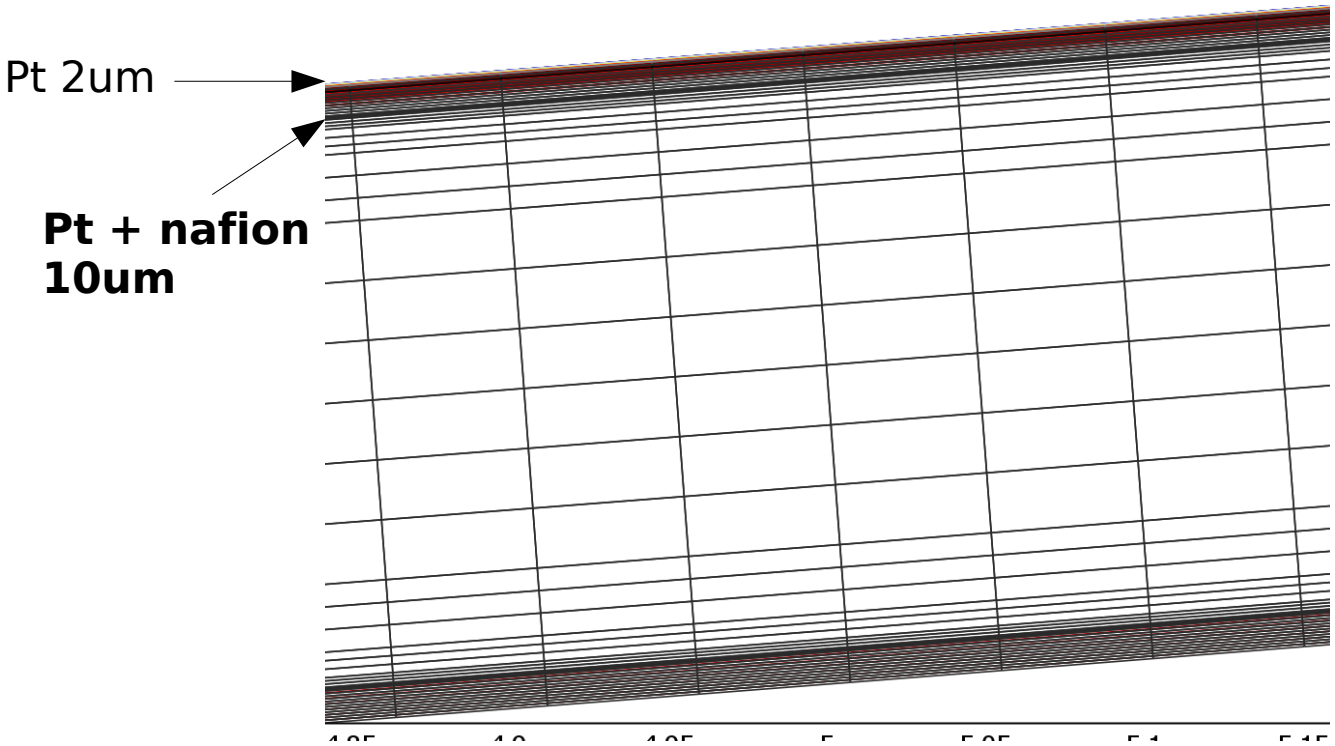
# New developements

- New meshing techniques for 2D model:
  - Squares instead of triangles – gives a huge advantage while modeling Pt layer separately – also quality of the simulations is better



# New developements

- Introduced an extra layer
  - As Pt is diffused into the Nafion, it probably causes changes in the stiffness near the surface.
  - Introduced about 10um thick layer between pure nafion and pure Pt – layer of mixture of Nafion and Pt
    a. Young modulus? Could it be between the Nafion and Pt ?



# Work on my paper

- Done
  - Most of the text
  - Some images
  - Updated model, updated oscillation model – some testing and improvements (as described before)

- Yet todo:
  - Compare my updated model to measurement results
  - Adjust empirical parameters in my model
  - Could be nice to have a 3D simulation result as an image for the paper.

# Other things

- Fair amount of Fluid dynamics in my life recently:
  - The class I'm taking in phys. dept.
  - We submitted 2 articles to ICAR2007 conference (South Korea) about a underwater vehicle
    - Some fluid dynamics calculations and theory were mine to do..