**Diffusion Project update (Feb. 2023)**

Since my original project description there have been three developments that make the project more interesting than my original description.

1. While I still suggest proceeding as outlined originally, we have experiments using tracer isotope diffusion of oxygen , which have enabled us to see more clearly where new oxide forms. In this case is both at the metal-scale interface and at the gas-metal interface. The average instantaneous profile of isotope through the scale is not monotonically decreasing from the gas-scale interface, but goes downward in the middle, before rising where the new scale is formed at the metal. It is challenging to understand this shape.
2. I derived a simple model for tracer diffusion based only on transport by oxygen vacancies in one dimension, which I have written up in the note ‘IsotopeDiffusion-v3.pdf’. I then discovered the two papers by Mishin and Borchardt (MB), the first of which presents a theory for computing the profile of isotope in a model isotope diffusion experiment. Their model is in two dimensions, since although most of the diffusion is along the grain boundaries (y-direction), they also consider diffusion into the grains (x-direction). They make the steady-state assumption, i.e. total oxygen and aluminium profiles can be assumed constant in time for the purpose of calculating fluxes. And they don’t suggest how to deal with a moving boundary. The papers are difficult, because they also derive some analytic solutions in specific limits.
3. To understand the situation better, I coded my simple model, using MB’s idea for the boundary conditions at the interfaces, but without the proper treatment of diffusion in the x-direction. ‘Scale\_growth\_v7.pdf’ is copy of my code, which was written in a Jupyter notebook. It included moving boundaries but does not yet explain the shape of the profile. It seems the isotope fraction becomes nearly 100% before the scale has time to grow significantly. At the beginning of the code I have written some notes explaining the notation and the model in more depth.