Review: "Orientation selective grain sublimation-deposition in snow under temperature gradient metamorphism observed with Diffraction Contrast Tomography" by Granger et al

General

This paper investigates for the first time temperature gradient metamorphism by combined in-situ diffraction contrast and absorption tomography for a combined analysis of the coupled geometrical and crystallographic microstructure evolution in snow.

Seeing the feasibility of these kind of experiments is very exicting. This is without doubt very original work that warrants publication. Suggestions for improvements are given below including a few questions about the analysis from which the (in fact far-reaching) conclusion of "measurable signatures of crystal anisotropy in the interface evolution in TG metamorphism" is drawn.

And btw, apologies for the delayed review.

Best wishes,
Henning Löwe

Specific

(p1, l6): why "indeed"?

(p2, l2): "ensuring..." statement not clear.

(p3, l3): What are the specifications of CellDyM2 in terms of possible temperatures and temperature gradients when used in the beamline? Related to the question if the choice of experimental conditions used here is motivated technically or physically.

(p3, l7): "parasitic" does not fit here (and throughout)

(p4, l13): "metamorphised" → metamorphosed

(p5, l5): "consists in" → consists of

(p5, l8): what determines the conditions? why is COMSOL required?

(p5, Sec 2.2.): Is it possible to rule from the settings that that the absorbed energy is not sufficient to change the thermodynamic state of the snow sample? I just heard from other synchrotron experiments that this may be delicate.

(p13, l9): I don't understand, *all* indices are zero in an isotropic system, right?

(p14, l1): Given these values, I don't understand the statement that the fabric is isotropic.

(p15, l2): "Noting" → denoting by

(p15, l2): I couldn't find the paper (Flin 2018), the bibitem is incomplete. It's important to have sufficient information at hand on how d is computed since it is essential for the conclusion.

(p14, l14): k should be italic in $\boldsymbol{n}_k$

(p16, l5): What's the bin-size in angle space?

(p17, l8): "absolute mean fluxes" → mean absolute fluxes? What exactly is computed to be equal to 10^{-8}?

(Figs 17,18): What causes the apparent "layering" in γ direction? An artefact of the finite number of normal vector classes of the algorithm on voxel data? Hm, seems unlikely though, since the early stage doesn't show this layering. An explanation and a discussion of the relevance/irrelevance of this effect for the main conclusion seems justified.

(p18, l2-8): It's difficult to comprehend the statements about the α dependence as a function of γ from the 2D histograms (It's nice though, that they are included). It would be helpful to re-cast these statements drawn from Fig 17,18 into one or two additional normal figures showing the α and β dependence for $\gamma = 0, 90, 180$ with error bars for e.g. one example for each of the 3 experimental phases. This will also help in the discussion.

Along these lines of error bars: Since $\gamma = 0, 180$ corresponds to up/down interfaces with the largest displacements, the computation of normal distances may (depending on how its computed) be subject to the largest errors bars. So the question is how robust is the α, β signal for these orientations?

(Fig 17/18): Another question that comes to my mind: As described in Sec 3.6, mean fluxes computed form Eq. (3) are used to assess the orientation dependence of the growth law via the dependence on α, β angle coordinates. As far as I understand, angles were determined *per surface node* of the triangulated interface mesh and the flux via Eq. (2). Can it be ruled out that there is no artificial correlation left of the "flux" on the underlying mesh heterogeneity? Surface patches in facet regions will likely end up with larger triangles than high-index surfaces due to the difference in curvatures. Doesn't a computation of fluxes from nodal α, β data without including area-weights understimate the fluxes on facets?

(p21, l3): What do you mean by "slowly evolving" and "evolving well"? It might be more concise to rephrase these statements in terms of the angles and velocities introduced before. This also makes the link of the "small cutout example" to the histograms shown before more tight.

(p22, l3): Is this really the total maximum flux/velocity computed? Or is it the maximum over the bin-mean? Then it depends on bin size?

(p22, l6): "litterature" $\rightarrow$ literature

(p22, l16): "stronger" $\rightarrow$ higher

(Discussion general): One aspect that should be included in the discussion is the common observation of an up/down asymmetry between sublimating and growing surfaces in TG metamorphism (e.g. Calonne TC, 2014 / Krol, Acta, 2018) How does this align with the present interpretation?

(p22, l17): I still don't entirely understand how the effect of "kinetic favor" ($\beta = 90$) is eventually discerned in the data from the effect of being "geometrically favorable" ($\gamma = 0, 180$) with respect to the TG direction. This connects back to the comment above (p18, l2-8), where a remaining β signal (beyond error bars) should be detectable for having ($\gamma = 0, 180$) fixed.

(p22, Sec 4.2): Also the statements in this section would benefit from an additional contraction (as suggested above) of the information in the 2D histograms into additional normal figures.