Supplementary material 4:

Pitsch rotations A and B, disclinations and dislocations.

The concept was first introduced by Volterra (1907) who considered two types of dislocations: rotational dislocations (disclinations) and translational dislocation (simply referred as dislocations nowadays). The disclination strength is given by an axial vector ***w***, called Frank vector, encoding the rotation needed to close the system, such as the dislocation strength is given by its Burgers vector **b** encoding the translation needed to close the Burgers circuit. If dislocations constitute a fundamental part of metallurgy, disclinations remain less used, with theories developed by Romanov (2003), Friedel and Kleman (2008), and applications mainly limited to highly deformed metals by cold-work (Klimanek *et al.*, 2001) or mechanical milling (Murayama *et al*., 2002).

Rotation A

The 60° to 70.5° distortion associated to rotation A can be represented by a wedge disclination of Frank axial vector $\boldsymbol{w}_{2A}$ = (-10.5°, $[110]_\gamma$), and can be decomposed into two equal closing wedge disclinations $\boldsymbol{w}_A$ = (-5.25°, $[110]_\gamma$) on each face of the α nucleus. A microscopic scale, the wedge disclinations can result from pile-ups on the $(\bar{1}10)_\gamma$ plane of edge sessile dislocations of line $[110]_\gamma$ and Burgers vectors **b** = $[\bar{1}10]_\gamma$ lying on the $(001)_\gamma$ plane (Fig. S4_1b). In that case, they could be associated to Lomer-Cottrell locks (Lomer, 1951; Cottrell, 1952). By simplification, the dissociation into Shockley partials introduced by Cottrell is not taken into account. The glide planes $(\bar{1}11)_\gamma$ and $(1\bar{1}1)_\gamma$ intersect into the x = $[110]_\gamma$ line. The Lomer locks can be obtained as follows: the ½ $[0\bar{1}1]_\gamma$ dislocation lying on the former plane combines with the ½ $[10\bar{1}]_\gamma$ dislocation lying on the latter plane to form an edge ½ $[1\bar{1}0]_\gamma$ dislocation on the $(001)_\gamma$ plane, which is not a slip plane for γ lattice, (Fig. S4_1d). Kajiwara, Ogawa & Kikuchi (1996) and Ogawa & Kajiwara (2007) have shown by High Resolution TEM images along the electron beam direction x = $[111]_\alpha$ = $[110]_\gamma$ that the $(\bar{1}11)_\gamma$ plane is gradually curved into a $(\bar{1}10)_\alpha$ plane, with the existence of a transient lattice and sets extra-half $(\bar{1}11)_\gamma$ planes at the γ/α interface. These interesting features seem in agreement with the disclination $\mathbf{w}_A$.

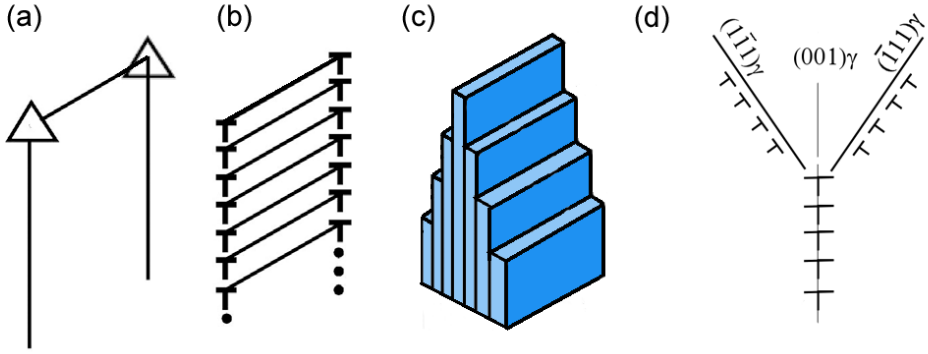

Fig. S4_1. Wedge disclination viewed (a) by its symbolic representation, (b) as a pile-up of edge dislocations, (c) as series of additional planes, freely adapted from Romanov (2003). (d) Creation of the dislocation pile-up by Lomer-Cottrell lock.

Rotation B

The closing rotation is the rotation B, and the pair of associated wedge disclinations are $\boldsymbol{w_B}$ = (-5.25°, $[\bar{1}11]_\gamma$). Such disclinations can probably be obtained by a superposition of pairs or triplets of screw dislocations on the $(\bar{1}11)_\gamma$ plane. The two sets of screw dislocations with Burgers vectors $b_1 = ½ [111]_\alpha = ½ [110]_\gamma$ and $b_2 = ½ [\bar{1}11]_\alpha$ shown by Shibata et *al.* (2010) on HRTEM images along the electron beam $[\bar{1}10]_\alpha = [001]_\gamma$ could correspond to the disclination $\mathbf{w}_B$.

The exact nature and structure of dislocations at the austenite/martensite interface is beyond the scope of the paper. A theoretical approach based on disconnections and named topological model has been developed by Pond, Ma & Hirth (2008). Future work is required to establish a link between the mesoscale one step model and the microscale topological model.