

## Supplementary materials

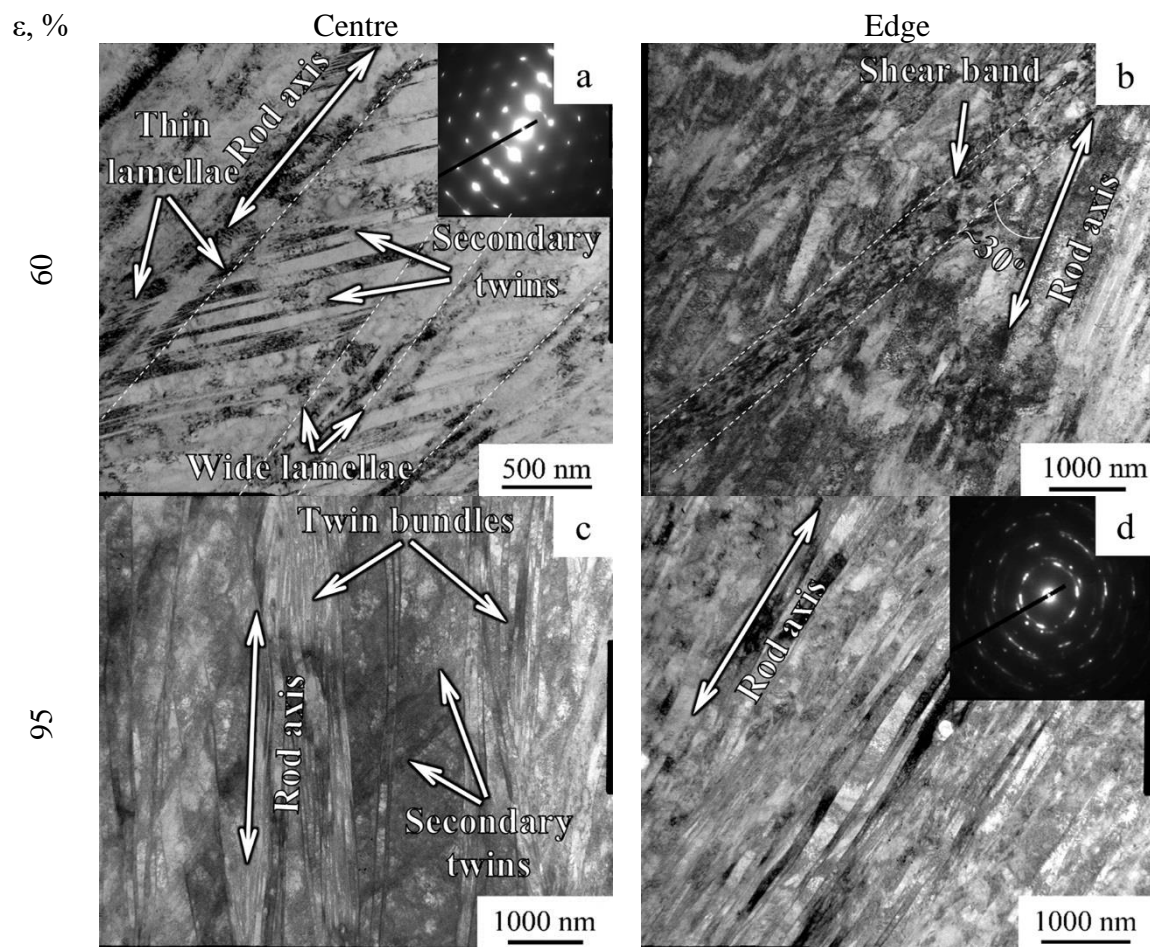


Figure S1. Longitudinal TEM structure after different swaging modes.

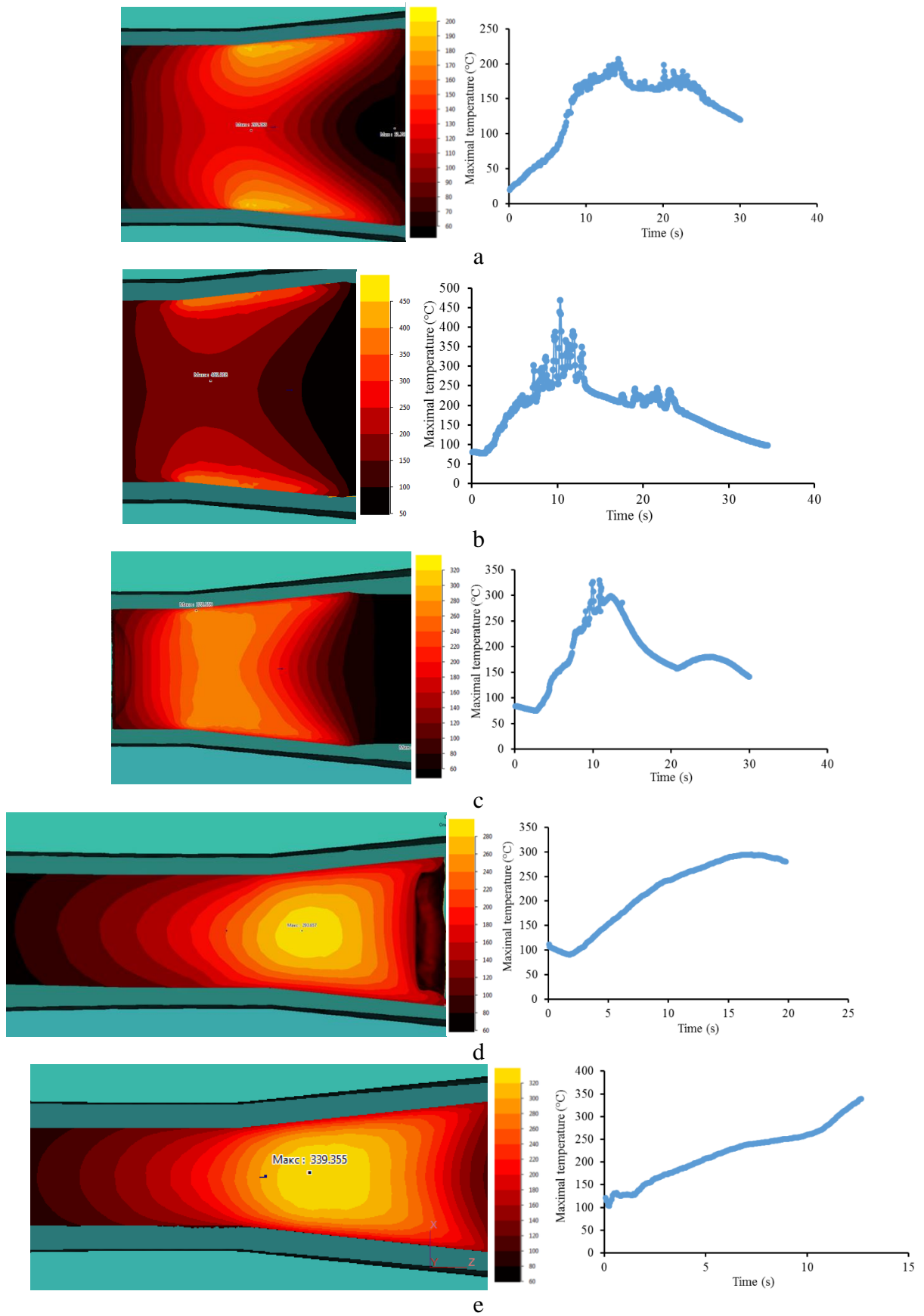


Figure S2. Heating of the rod during swaging at (a) the 1<sup>st</sup> (20%), (b) 2<sup>nd</sup> (40%), (c) 3<sup>rd</sup> (60%), (d) 4<sup>th</sup> (80%), and (e) 5<sup>th</sup> (95%) steps of the processing.

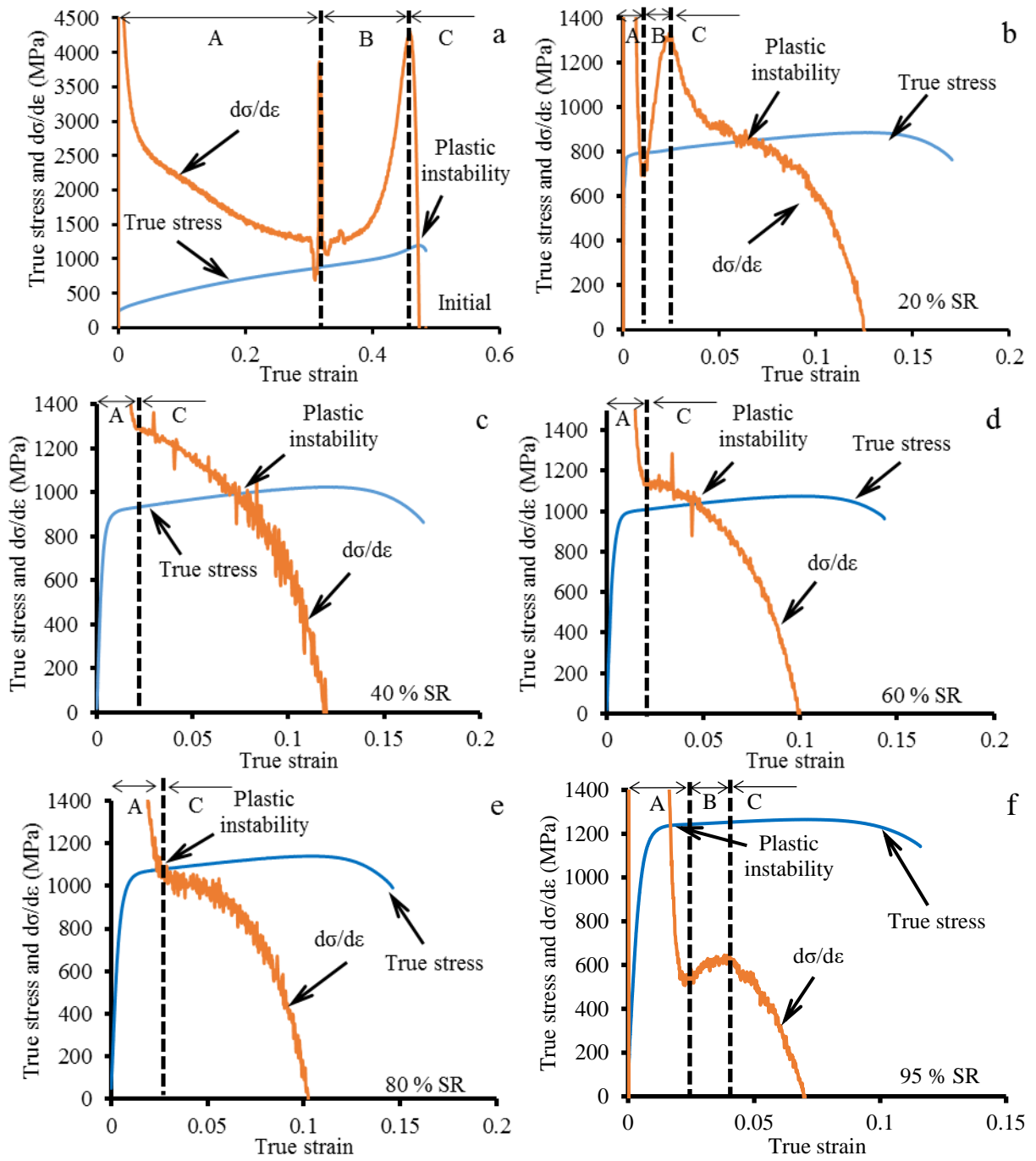


Figure S3. True stress-true strain and  $d\sigma/d\varepsilon$ -true strain plots for the program steel in (a) the as-received condition and after (b) a 20%, (c) 40%, (d) 60%, (e) 80%, and (f) 95% swaging reduction (SR).