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Data Article

Residual stress measurements via neutron diffraction of additive manufactured stainless steel 17-4 PH

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ABSTRACT

Neutron diffraction was employed to measure internal residual stresses at various locations along stainless steel (SS) 17-4 PH specimens additively manufactured via laser-powder bed fusion (L-PBF). Of these specimens, two were rods (diameter=8 mm, length=80 mm) built vertically upward and one a parallelepiped ($8 \times 80 \times 9$ mm^3) built with its longest edge parallel to ground. One rod and the parallelepiped were left in their as-built condition, while the other rod was heat treated. Data presented provide insight into the microstructural characteristics of typical L-PBF SS 17-4 PH specimens and their dependence on build orientation and post-processing procedures such as heat treatment. Data have been deposited in the Data in Brief Dataverse repository (doi:10.7910/DVN/T41S3V).

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Specifications Table

Subject area	Mechanical Engineering
More specific subject area	Additive Manufacturing
Type of data	Tables; Graphs; Excel Worksheets
How data was acquired	Neutron diffraction, BT8 neutron diffractometer at National Institute of Standards and Technology (NIST) Center for Neutron Research (CNR)
Data format	Raw and analyzed
Experimental factors	Three stainless steel (SS) 17-4 PH specimens were fabricated from gas-atomized powder using laser powder bed fusion (L-PBF). Optimized process parameters were employed to generate two vertical rods and a similar-dimensioned, horizontal parallelepiped. Specimens were removed from the build plate using electrical discharge machining (EDM). Heat treatments (solution annealing and aging) were applied to one of the as-built, cylindrical specimens. The other two specimens remained in their as-built condition. Specimen surfaces were cleaned.
Experimental features	Residual stresses at specific locations along the radius and length of cylindrical rods and the x,y,z directions for the parallelepiped were measured using neutron diffraction. Effects of heat treatment and build direction on the residual stress distribution in L-PBF SS 17–4 PH may be determined using the presented tables and plots.
Data source location	NIST CNR, Gaithersburg, Maryland, USA
Data accessibility	Data have been deposited in the Data in Brief Dataverse repository (doi:10.7910/DVN/T41S3V). https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/T41S3V

Value of data

- Residual stress can lead to premature fatigue failure and deformation of parts. Therefore, understanding and characterizing residual stress is important for ensuring part reliability. Data provided aid in characterizing residual stress distributions in specimens fabricated via laser powder bed fusion (L-PBF) and other directed energy, powder-based additive manufacturing (AM) methods.
- Data can be used to explain fatigue and deformation behavior of AM parts observed by others.
- Data demonstrate effects of heat treatment and building orientation on residual stress distributions in stainless steel (SS) 17-4 PH specimens made via L-PBF.
- Data provide a means to generate and validate numerical and/or analytical thermomechanical models for their prediction of residual stress in AM parts.
- Data can be used as an educational tool for learning how to calculate residual stresses given raw measurements obtained via neutron diffraction of metals.
- Data may be compared with residual stress measurements found via other techniques.

1. Data

The residual stress within heat treated and as-built (or, 'as-is') stainless steel (SS) 17-4 PH specimens fabricated via laser powder bed fusion (L-PBF) were measured using neutron diffraction at NIST's Center for Neutron Research (CNR). The presented data include measured lattice strains (i.e. d-spacings), stress-free lattice spacings (d_0) and hoop/axial (or x-,y-,z-component) residual stress calculations. Uncertainties associated with residual stress measurements are estimated and also