Data Article

Fatigue data for polyether ether ketone (PEEK) under fully-reversed cyclic loading

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ABSTRACT

In this article, the data obtained from the uniaxial fully-reversed fatigue experiments conducted on polyether ether ketone (PEEK), a semi-crystalline thermoplastic, are presented. The tests were performed in either strain-controlled or load-controlled mode under various levels of loading. The data are categorized into four subsets according to the type of tests, including (1) strain-controlled fatigue tests with adjusted frequency to obtain the nominal temperature rise of the specimen surface, (2) strain-controlled fatigue tests with various frequencies, (3) load-controlled fatigue tests without step loadings, and (4) load-controlled fatigue tests with step loadings. Accompanied data for each test include the fatigue life, the maximum (peak) and minimum (valley) stress–strain responses for each cycle, and the hysteresis stress–strain responses for each collected cycle in a logarithmic increment. A brief description of the experimental method is also given.

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Specifications Table

| Subject area | Engineering |
|--------------|-------------|
| More specific subject area | Fatigue of polymers |

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## Value of the data

- The data provided in this paper are the results of the experimental investigation using the $\varepsilon$–$N$ approach to obtain the fatigue properties of PEEK thermoplastic, which can be used to validate various fatigue models for polymers.
- The presented data provide the overall cyclic deformation and fatigue behavior of PEEK polymer under different cyclic loading modes. The test method can be generalized for other semi-crystalline polymers.
- The stress–strain responses provided in this paper can be used to obtain the frequency effects on PEEK fatigue behavior.

## 1. Data

The presented data sets are categorized into four Microsoft Excel workbooks according to the type of tests. The workbook named (1) "Nominal Temperature," contains the strain-controlled fatigue tests with adjusted frequency to achieve nearly fixed strain rates, and thus, similar nominal temperature rise in all fatigue tests, (2) "Frequency Effect Tests," contains the strain-controlled fatigue tests with various frequencies, (3) "Load-Controlled Test," contains load-controlled fatigue tests under constant amplitude loadings, and (4) "Load-controlled Step Test," contains load-controlled fatigue tests with step loadings. A summary of each test with corresponding strain/stress amplitudes, test frequency, specimen name, and fatigue life are presented in Tables 1 and 2 for strain-controlled and load-controlled tests, respectively. The data have been deposited to the Data in Brief Dataverse: [http://dx.doi.org/10.7910/DVN/YSFURO](http://dx.doi.org/10.7910/DVN/YSFURO).

## 2. Experimental design, materials and methods

The study was conducted on a neat PEEK polymer [1]. Fatigue specimens were machined using a CNC lathe to produce a cylindrical dog-bone shape with the gage diameter of 6.35 mm and gage length of 18 mm following ASTM E606-04 standard [2]. The specimens were further polished using different grit sand papers to remove any mark from machining on the gage section of the specimen.

All of the uniaxial fully-reversed fatigue tests were conducted under strain-controlled or load-controlled loading condition following the ASTM D7791 standard [3]. The fatigue tests were performed using MTS 858 closed-loop servo hydraulic load frame with a 25 kN load cell. The strain introduced on the gage section of the specimen was obtained using a MTS axial extensometer with a gage length of 15 mm. Due to high damping characteristic of polymers, the rise in temperature in PEEK specimens is sensitive to the test frequency (i.e. strain rate) and strain/load amplitude. Thus, a
### Table 1
Summary for uniaxial fully-reversed ($R = -1$) strain-controlled fatigue tests.

| Specimen ID | Strain amplitude, $\varepsilon_a$ (mm/mm) | Frequency (Hz) | Reversals to failure, $2N_f$ |
|-------------|------------------------------------------|----------------|-----------------------------|
| Nominal Temperature Tests | | | |
| S50 | 0.02 | 3 | 1,449,114 |
| S21 | 0.025 | 1 | 948,248 |
| S22 | 0.03 | 0.75 | 475,810 |
| S19 | 0.03 | 0.75 | 179,018 |
| S46 | 0.035 | 0.5 | 208,896 |
| S47 | 0.04 | 0.5 | 124,030 |
| S42 | 0.04 | 0.5 | 92,078 |
| S43 | 0.04 | 0.5 | 48,090 |
| S35 | 0.04 | 0.5 | 46,772 |
| S24 | 0.04 | 0.5 | 306 |
| S25 | 0.04 | 0.5 | 18,454 |
| S23 | 0.04 | 0.5 | 14,172 |
| | | | 7766 |
| Frequency Effect Tests | | | |
| S20 | 0.02 | 1 | 1,723,898 |
| S94 | 0.025 | 2 | 1,460,066 |
| S26 | 0.03 | 0.75 | 437,176 |
| S28 | 0.03 | 0.5 | 51,472 |
| S53 | 0.035 | 1 | 15,716 |
| S59 | 0.035 | 0.75 | 216,650 |
| S34 | 0.035 | 0.5 | 32,076 |
| S4 | 0.035 | 0.25 | 53,968 |
| S8 | 0.035 | 0.75 | 153,206 |
| S56 | 0.035 | 0.25 | 46,772 |
| S95 | 0.04 | 0.75 | 4306 |

### Table 2
Summary for uniaxial fully-reversed ($R = -1$) load-controlled fatigue tests.

| Specimen ID | Stress amplitude, $\sigma_a$ (MPa) | Frequency (Hz) | Reversals to failure, $2N_f$ |
|-------------|-----------------------------------|----------------|-----------------------------|
| Load-Controlled Tests | | | |
| S61 | 45 | 0.75 | > 2,000,000 |
| S71 | 7 | 0.75 | > 2,000,000 |
| S72 | 70 | 2 | 109,294 |
| S68 | 80 | 0.5 | 6444 |
| S69 | 80 | 0.75 | 7404 |
| S70 | 80 | 1.5 | 9716 |
| Load-Controlled Step Tests | | | |
| S65 | 100–45 | 0.4 | 172 |
| S64 | 100–45 | 0.4 | 306 |
| S66 | 100–45 | 0.6 | > 52,810 |
| S63 | 100–45 | 0.75 | > 2,000,000 |

*a Specimen failed due to necking.*
laser thermometer was used to monitor the temperature on the gage section of the specimen during fatigue tests [1].

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Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.dib.2016.01.052.

References

[1] R. Shrestha, J. Simsiriwong, N. Shamsaei, R.D. Moser, Cyclic deformation and fatigue behavior of polyether ether ketone (PEEK). Int. J. Fatigue 83 (3) (2016) 427–441.
[2] ASTM E606-04, Standard Practice for Strain-Controlled Fatigue Testing, ASTM International, West Conshohocken, PA, 2004.
[3] ASTM D7791-12, Standard Test Method for Uniaxial Fatigue Properties of Plastics, ASTM International, West Conshohocken, PA, 2012.