Supplementary Information for: Enhancing Material Characterization: Multi-Fidelity Deep Neural Network for Stress-Strain Curve Prediction from Small Punch Test Data

1 Software Environment and Dependencies

To reproduce the results in this study, please ensure that all required packages are installed:

```
pip install -r requirements.txt
```

The key dependencies include:

- numpy
- pandas
- torch (PyTorch)
- scikit-learn
- scipy
- openpyxl

For the complete list of dependencies, please refer to the `requirements.txt` file included in the supplementary materials.

2 Data Files Description

SPT-curve.xlsx

This file contains the Small Punch Test (SPT) simulation data used for training and testing across Experiments 1–4.

Stress-Strain.xlsx

This file contains the uniaxial tensile stress–strain data from FEM simulations used in Experiments 1–4.

3 Finite Element Simulation Files

All finite element simulations were conducted using LS-DYNA R2023.
SPT-FEM folder: This folder contains the main `Main.key` driver deck along with associated control, contact, boundary, and material definition files. Users may execute the model directly or substitute different material cards by modifying the `INCLUDE Parameter material` entry, which links to the `DATABASE MATERIAL` section. This modular structure allows users to simulate different high-strength steels.
Tensile-FEM folder: This folder contains the FEM files for uniaxial tensile simulations. By running these files, users can obtain the stress–strain curves under standard tensile loading conditions for the studied materials.

4 Model Code and Usage

MFDNN.py
This file contains the model definition for the Multi-Fidelity Deep Neural Network (MFDNN) architecture used in this work.
Usage Notes:

- Use `SPT-curve.xlsx` as the model input.
- Prior to training, data preprocessing is required to extract physically meaningful features.
- For details on the preprocessing workflow, please refer to:

  Yang, Zheng-Ni, et al. "Machine learning-based extraction of mechanical properties from multi-fidelity small punch test data." *Advances in Manufacturing*, 2025.

5 Real Experimental Data Disclaimer

Due to commercial confidentiality agreements with our industrial partners, the real experimental material data used in this study cannot be publicly released. We appreciate your understanding.