

## Supplementary Information

### Cross-scale backscattered-electron imaging and its application in revealing the microstructure-property relations

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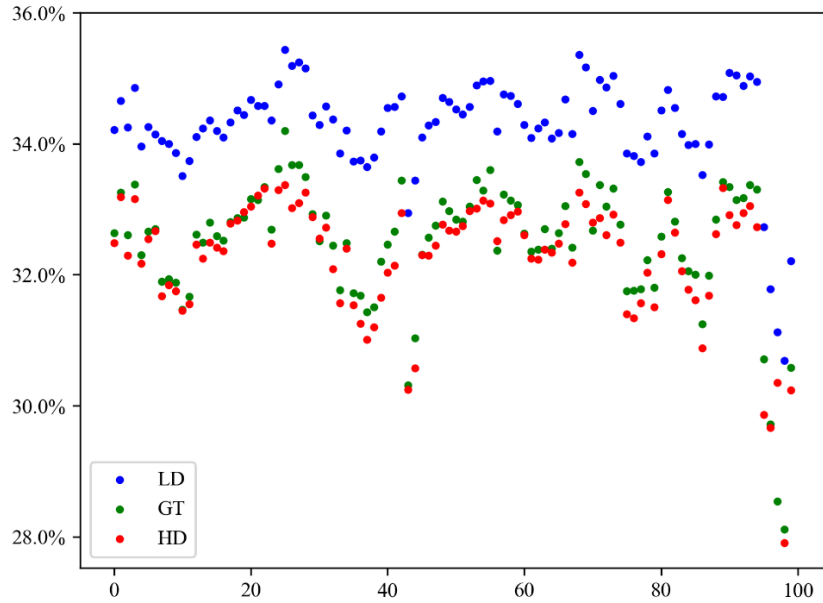
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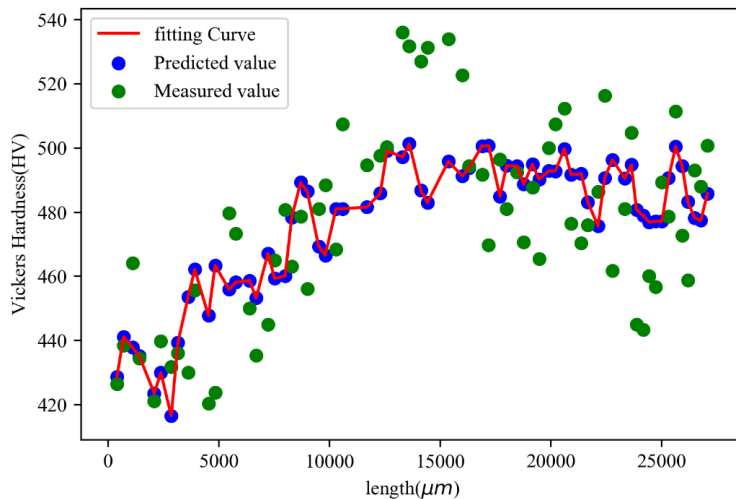
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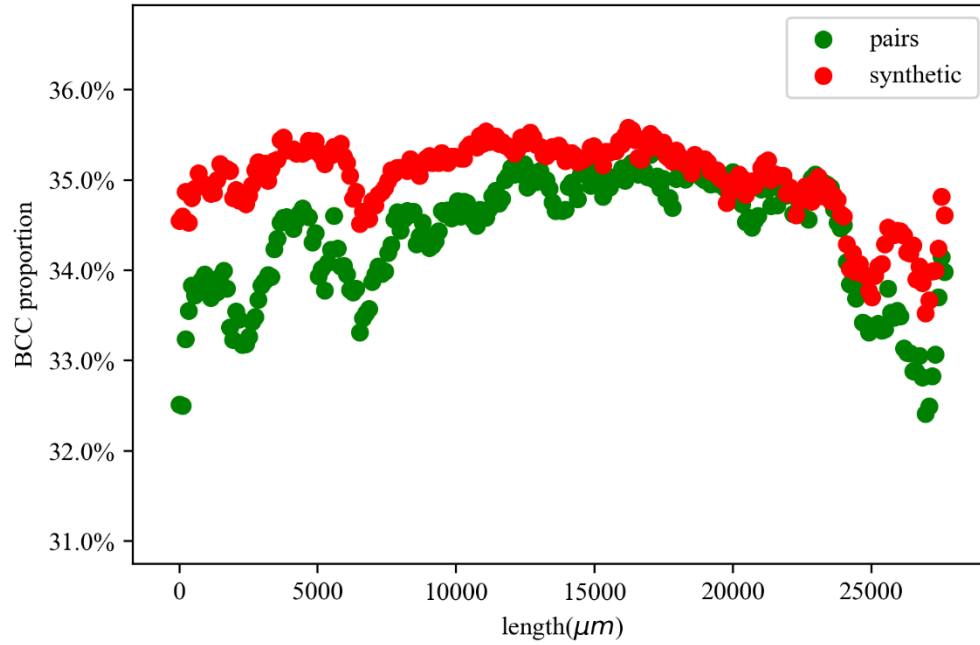
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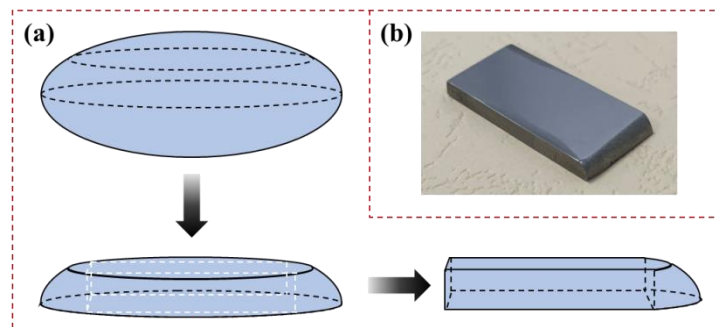
**Figure S1. The BCC phase statistics results for different image types.** LD represents low-definition images, GT denotes the ground-truth high-definition images, and HD corresponds to high-definition images generated using SEMGAN. The horizontal axis corresponds to the test image number, while the vertical axis indicates the corresponding phase fraction. We examined the differences in BCC phase fractions among different image types. Overall, the disparity between GT and HD is minimal, with errors averaging below 0.2%. LD exhibits larger differences from GT, averaging around 1.7%.



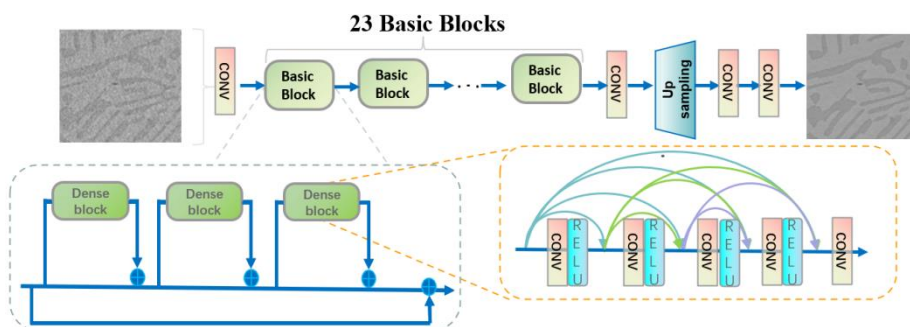
**Figure S2. Use lamellar structure distribution, BCC phase distribution and lamella width distribution to fit the hardness.** The correlation is 0.7154. Although it is improved compared to the BCC phase, there is an overfitting trend.



**Figure S3. BCC phase statistics are performed using pairs model and synthetic model respectively.** Although there is a numerical gap between synthetic and pairs, the overall distribution trend is basically maintained.



**Figure S4. a** Schematic diagram of the AlCoCrFeNi<sub>2.1</sub> EHEA sample. **b** Oblique view of the AlCoCrFeNi<sub>2.1</sub> EHEA ingot.



**Figure S5. Architecture of Generator Network.**