**Dataset description**

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This dataset contains the raw data used for the publication:

**2D materials-based homogeneous transistor-memory architecture for neuromorphic hardware**

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1. This is an open-access dataset. Please refer to the above publication when using the data presented in this dataset.

2. You can contact us for any question you may have.

**File summary:**

|  |  |  |
| --- | --- | --- |
| Data presented in the Manuscript | Fig. 1 | Files 1-13 |
| Fig. 2 | Files 14-24 |
| Fig. 3 | Files 25-33 |
| Fig. 4 | Files 34-42 |
| Data presented in the Supplementary Materials | Fig. S1 | Files 43-58 |
| Fig. S2 | Files 59-75 |
| Fig. S3 | Files 76-82 |
| Fig. S4 | Files 83-102 |
| Fig. S5 | Files 103-122 |
| Fig. S6 | Files 123-128 |
| Fig. S7 | Files 129-135 |
| Fig. S8 | Files 136-137 |
| Fig. S9 | Files 138-148 |
| Fig. S10 | Files 149-150 |
| Fig. S11 | Files 151-159 |
| Fig. S12 | File 160 |
| Fig. S13 | Files 161-162 |
| Figs. 3 and S16 of our first submission.  These files are NOT presented in the final version of the Manuscript or Supplementary Materials | | File 163-173 |

**File descriptions:**

1. Image file “Fig. 1A, 1C-left.tif”:

The schematic of the device structure for Fig. 1A and 1C-left, draw with Blender.

2. Image file “Fig. 1B.eps”:

The schematic of the FE-induced doping for Fig. 1B, draw with Adobe Illustrator.

3. Image file “Fig. 1C-right.tif”:

The schematic of the device structure for Fig. 1C, draw with Blender.

4. Image file “Fig. 1D.eps”:

The schematic of the memory mechanism for Fig. 1D, draw with Adobe Illustrator.

5. Data file “Fig. 1E, S3C, S3D.xlsx”:

The transistor functionality with common-base configuration for the NPN BJT.

Fig. 1E is a 3D plot. Fig. S3C is a 2D mapping figure.

Fig. S3D is the collector-emitter current gain calculated based on this data file.

6. Data file “Fig. 1F, S3G, S3H.xlsx”:

The transistor functionality with common-emitter configuration for the NPN BJT.

Fig. 1F is a 3D plot. Fig. S3G is a 2D mapping figure.

Fig. S3H is the collector-base current gain calculated based on this data file.

7. Data file “Fig. 1G, S7B.xlsx”:

Current rectification for the potentiation process.

Fig. 1G is a 2D mapping figure. Fig. S7B is a line graph.

8. Image file “Fig. 1G.tif”:

2D mapping figure for Fig. 1G in the manuscript, draw with Matlab.

9. Data file “Fig. 1H, S7C.xlsx”:

Current rectification for the depression process.

Fig. 1H is a 2D mapping figure. Fig. S7C is a line graph.

10. Image file “Fig. 1H.tif”:

2D mapping figure for Fig. 1H in the manuscript, draw with Matlab.

11. Image file “Fig. 1I-inset.eps”:

The schematic of the current measurement mechanism in Fig. 1I inset, draw with Adobe Illustrator.

12. Data file “Fig. 1I.xlsx”:

The channel current and resistance for *P*u- *P*d- *P*u and *P*u- *P*u- *P*u FE states in Fig. 1I.

13. Data file “Fig. 1J.xlsx”:

The channel current (conductance) for the potentiation and depression in Fig. 1J.

14. Image file “Fig. 2A.png”:

The schematic of the OPAMP for Fig. 2A, draw with Blender.

15. Image file “Fig. 2B.eps”:

The electric circuit of the OPAMP for Fig. 2B, draw with Adobe Illustrator.

16. Image file “Fig. 2C.png”:

The optical image of the OPAMP for Fig. 2C.

17. Data file “Fig. 2D-2F.xlsx”:

Analogue input signal (Fig. 2D), inverted (Fig. 2E) and non-inverted (Fig. 2F) output signal of the OPAMP.

18. Image file “Fig. 2E-inset.eps”:

The schematic of the inverted signal amplification for Fig. 2E inset, draw with Adobe Illustrator.

19. Image file “Fig. 2F-inset.eps”:

The schematic of the non-inverted signal amplification for Fig. 2F inset, draw with Adobe Illustrator.

20. Image file “Fig. 2G-inset.eps”:

The schematic of the addition calculation for Fig. 2G inset, draw with Adobe Illustrator.

21. Data file “Fig. 2G.xlsx”:

The input and output analogue signal for the addition calculation in Fig. 2G.

22. Data file “Fig. 2H.xlsx”:

The input and output analogue signal for the integral calculation in Fig. 2H. Square input signal.

23. Data file “Fig. 2I-inset.eps”:

The schematic of the integral calculation for Fig. 2I inset, draw with Adobe Illustrator.

24. Data file “Fig. 2I.xlsx”:

The input and output analogue signal for the integral calculation in Fig. 2I. Sinusoidal input signal.

25. Data file “Fig. 3A.xlsx”:

The bias for the letter and number patterns in Fig. 3A.

26. Image file “Fig. 3B.eps”:

The schematic of the classification mechanism for Fig. 3B, draw with Adobe Illustrator.

27. Image file “Fig. 3C.eps”:

The schematic of the electric circuit for Fig. 3C, draw with Adobe Illustrator.

28. Data file “Fig. 3D.xlsx”:

The output character of the VC for Fig. 3D.

29. Data file “Fig. 3E.xlsx”:

The training dataset label for Fig. 3E.

30. Data file “Fig. 3F.xlsx”:

The predicted class in the simulation for Fig. 3F.

31. Data file “Fig. 3G.xlsx”:

The predicted class in the experiment for Fig. 3G.

32. Data file “Fig. 3H.xlsx”:

Average Score(V) in the simulation and experiment for Fig. 3H.

33. Data file “Fig. 3I-3J.xlsx”:

Accuracy and cost in the simulation and experiment for Figs. 3I-3J.

34. Image file “Fig. 4A.png”:

The schematic of the TCAM cell with data ‘1’ for Fig. 4A, draw with Blender.

35. Image file “Fig. 4B.eps”:

The electric circuit of the TCAM cell with data ‘1’ for Fig. 4B, draw with Adobe Illustrator.

36. Image file “Fig. 4C.png”:

The schematic of the TCAM cell with data ‘0’ for Fig. 4C, draw with Blender.

37. Image file “Fig. 4D.eps”:

The electric circuit of the TCAM cell with data ‘0’ for Fig. 4D, draw with Adobe Illustrator.

38. Image file “Fig. 4E.png”:

The schematic of the TCAM cell with data ‘X’ for Fig. 4E, draw with Blender.

39. Image file “Fig. 4F.eps”:

The electric circuit of the TCAM cell with data ‘X’ for Fig. 4F, draw with Adobe Illustrator.

40. Image file “Fig. 4G-bottom.jpg”:

The optical image of the chip for Fig. 4G-bottom.

41. Image file “Fig. 4G-top.jpeg”:

The photograph of one TCAM cell Fig. 4G-top.

42. Data file “Fig. 4H.xlsx”:

The current and conductivity of the TCAM cell with data ‘1’ for Fig. 4H.

42. Data file “Fig. 4I.xlsx”:

The current and conductivity of the TCAM cell with data ‘X’ for Fig. 4I.

43. Image file “Fig. S1A.jpg”:

The PFM amplitude for Fig. S1A.

44. Data file “Fig. S1B-inset.xlsx”:

The PFM phase along the dashed line in Fig. S1B.

45. Image file “Fig. S1B.jpg”:

The PFM phase for Fig. S1B.

46. Data file “Fig. S1C-inset.xlsx”:

The KPFM potential along the dashed line in Fig. S1C.

47. Image file “Fig. S1C.jpg”:

The KPFM potential for Fig. S1C.

48. Image file “Fig. S1D.jpg”:

The optical image of the FET for Fig. S1D.

49. Image file “Fig. S1E.jpg”:

The optical image of the BJT for Fig. S1E.

50. Image file “Fig. S1F.tif”:

The SEM image of the WSe2-FE interface for Fig. S1E.

51. Data file “Fig. S1G.xlsx”:

Raman spectra for Fig. S1G.

52. Data file “Fig. S1H.xlsx”:

Raman spectra for Fig. S1H.

53. Image file “Fig. S1I-inset Pd.jpg”:

Measured location in the *P*d domain.

54. Image file “Fig. S1I-inset Pu.jpg”:

Measured location in the *P*u domain.

55. Data file “Fig. S1I.xlsx”:

PL spectra for Fig. S1I.

56. Data file “Fig. S1J-S1K.xlsx”:

Absorption spectra for Figs. S1J-S1K.

57. Data file “Fig. S1L.xlsx”:

Transfer curve for Fig. S1L.

58. Image file “Fig. S1M.eps”:

The schematic of the band diagram for Fig. S1M, draw with Adobe Illustrator.

59. Image file “Fig. S2A-S2C, bottom.eps”:

The circuit of the two-terminal device for Figs. S2A-S2C, draw with Adobe Illustrator.

60. Image file “Fig. S2A.png”:

The schematic of the two-terminal device for Fig. S2A, draw with Blender.

61. Image file “Fig. S2B.png”:

The schematic of the two-terminal device for Fig. S2B, draw with Blender.

62. Image file “Fig. S2C.png”:

The schematic of the two-terminal device for Fig. S2C, draw with Blender.

63. Data file “Fig. S2D.xlsx”:

The current rectification of the n-p and p-n junction for Fig. S2D.

64. Data file “Fig. S2E.xlsx”:

The current rectification of 20 n-p junctions for Fig. S2E.

65. Data file “Fig. S2F.xlsx”:

The current rectification of 20 p-n junctions for Fig. S2F.

66. Data file “Fig. S2G.xlsx”:

The current rectification of 20 n-n junctions for Fig. S2G.

67. Data file “Fig. S2H.xlsx”:

The current rectification of 20 p-p junctions for Fig. S2H.

68. Fig. S2I was draw with data file 64 and 65. Fig. S2J was draw with data file 66 and 67.

69. Data file “Fig. S2K.xlsx”:

Breakdown of the n-p junction for Fig. S2K.

70. Data file “Fig. S2L.xlsx”:

Current rectification for the n-p junction in Fig. S2L.

71. Data file “Fig. S2M.xlsx”:

Current rectification for the p-n junction in Fig. S2M.

72. Data file “Fig. S2N.xlsx”:

Current rectification for the n-n junction in Fig. S2N.

73. Image file “Fig. S2O, S3A, S3E, S3K.png”:

The schematic of 4 cascaded BJT devices, draw with Blender.

Fig. S2O: bridge rectifier.

Fig. S3K: differential amplifier.

74. Image file “Fig. S2P.eps”:

The electric circuit of the bridge rectifier for Fig. S2P, draw with Adobe Illustrator.

75. Data file “Fig. S2Q.xlsx”:

Current rectification for the bridge rectifier in Fig. S2Q.

76. Image file :Fig. S3B.eps”:

The electric circuit of the BJT with common-base configuration for Fig. S3B, draw with Adobe Illustrator.

77. Image file “Fig. S3C.tif”:

The 2D mapping figure of the transistor functionality with common-base configuration for Fig. S3C, draw with Matlab.

78. Image file “Fig. S3F.eps”:

The electric circuit of the BJT with common-emitter configuration for Fig. S3F, draw with Adobe Illustrator.

79. Image file “Fig, S3G.tif”:

The 2D mapping figure of the transistor functionality with common-emitter configuration for Fig. S3G, draw with Matlab.

80. Data file “Fig. S3I-S3J.xlsx”:

The input and output analogue signal under the common-emitter configuration for Figs. S3I-S3J.

81. Image file “Fig. S3L.eps”:

The electric circuit of the differential amplifier for Fig. S3L, draw with Adobe Illustrator.

82. Data file “Fig. S3M-S3N.xlsx”:

The input and output analogue signal for the differential amplifier in Figs. S3M-S3N.

83-102. Data files “Fig. S4-device1.xlsx” to “Fig. S4-device20.xlsx”:

Performances of 20 n-p-n BJTs under common-base configuration.

103-122. Data files “Fig. S5-device1.xlsx” to “Fig. S5-device20.xlsx”:

Performances of 20 n-p-n BJTs under common-emitter configuration.

123. Image file “Fig. S6A.png”:

The schematic of the FEFET for Fig. S6A, draw with Blender.

124. Image file “Fig. S6B.eps”:

The schematic of the FE-induced doping for Fig. S6B, draw with Adobe Illustrator.

125. Image file “Fig. S6C.eps”:

The schematic of the hysteretic transfer curve for Fig. S6C, draw with Adobe Illustrator.

126. Image file “fig. S6D.eps”:

The schematic of the memory mechanism for Fig. S6D, draw with Adobe Illustrator.

127. Data file “Fig. S6E-S6F.xlsx”:

The hysteretic transfer curves for Fig. S6E.

The resistances for Fig. S6F were calculated based on this file.

128. Data file “Fig. S6G.xlsx”:

The cumulative probability of HRS and LRS for Fig. S6G.

129. Data file “Fig. S7A.xlsx”:

The 26-level weight and the corresponding channel conductance for Fig. S7A.

130. Data file “Fig. S7D-S7E.xlsx”:

The channel conductance in multiple potentiation and depression cycles for Fig. S7D.

The conductance variance for Fig. S7E were calculated based on this file.

131. Image file “Fig. S7F.eps”:

The schematic of current measured for the HRS and LRS with different driving voltage *V*ce in Fig. S7F, draw with Adobe Illustrator.

132. Data file “Fig. S7G-S7H.xlsx”:

The dynamic current under *V*ce = 1 V for Fig. S7G.

The resistances for Fig. S7H were calculated based on this file.

133. Data file “Fig. S7I-S7J.xlsx”:

The dynamic current under *V*ce = 3 V for Fig. S7I.

The resistances for Fig. S7J were calculated based on this file.

134. Data file “Fig. S7K.xlsx”:

The retention performance for Fig. S7K.

135. Data file “fig. S7L.xlsx”:

The endurance performance for Fig. S7L.

136. Image file “Fig. S8A.eps”:

The schematic of the letter and number patterns for Fig. S8A, draw with Adobe Illustrator.

137. Data file “Fig. S8B.xlsx”:

The biases for each pattern in 30 epochs for Fig. S8B.

138. Image file “Fig. S9A-inset.eps”:

The schematic of the VC for Fig. S9A inset, , draw with Adobe Illustrator.

139. Data file “Fig. S9A.xlsx”:

The dynamic output of the VC for Fig. S9A.

140. Image file “Fig. S9B.eps”:

The schematic of the training process for binary classification in Fig. S9B, , draw with Adobe Illustrator.

141. Data file “Fig. S9C.xlsx”:

The updated conductance for each basic cell in the simulation for Fig. S9C.

142. Data file “Fig. S9D.xlsx”:

The updated conductance for each basic cell in the experiment for Fig. S9D.

143. Data file “Fig. S9E.xlsx”:

The Score(V) for each pattern in the simulation for Fig. S9E.

144. Data file “Fig. S9F.xlsx”:

The Score(V) for each pattern in the experiment for Fig. S9F.

145. Data file “Fig. S9G.xlsx”:

The bias for each pattern of the testing dataset in Fig. S9G.

146. Data file “Fig. S9H, S9J.xlsx”:

The Score(V) for each pattern of the testing dataset in the simulation for Fig. S9H.

The Score(I) for each pattern of the testing dataset in the simulation for Fig. S9J.

147. Data file “Fig. S9I, S9K.xlsx”:

The Score(V) for each pattern of the testing dataset in the experiment for Fig. S9I.

The Score(I) for each pattern of the testing dataset in the experiment for Fig. S9K.

148. Data file “Fig. S9L.xlsx”:

The pattern label, predicted class in simulation and in experiment for the testing data in Fig. S9L.

149. Data file “Fig. S10A.xlsx”:

The cumulative probability of the TCAM cell with bit data “1” for Fig. S10A.

150. Data file “Fig. S10B.xlsx”:

The cumulative probability of the TCAM cell with bit data “X” for Fig. S10B.

151. Image file “Fig. S11A.eps”:

Truth table of NOT logic for Fig, S11A. draw with Adobe Illustrator.

152. Image file “Fig. S11B.eps”:

The electric circuit of NOT logic for Fig. S11B, draw with Adobe Illustrator.

153. Data file “Fig. S11C-S11D.xlsx”:

The input and output voltage of NOT logic for Figs. S11C-S11D.

154. Image file “Fig. S11E.eps”:

Truth table of AND logic for Fig, S11E. draw with Adobe Illustrator.

155. Image file “Fig. S11F.eps”:

The electric circuit of AND logic for Fig. S11F, draw with Adobe Illustrator.

156. Data file “Fig. S11G-S11H.xlsx”:

The input and output voltage of AND logic for Figs. S11G-S11H.

157. Image file “Fig. S11I.eps”:

Truth table of OR logic for Fig, S11I. draw with Adobe Illustrator.

158. Image file “Fig. S11J.eps”:

The electric circuit of OR logic for Fig. S11J, draw with Adobe Illustrator.

159. Data file “Fig. S11K-S11L.xlsx”:

The input and output voltage of OR logic for Figs. S11K-S11L.

160. Data file “Fig. S12.xlsx”:

The dark current and photocurrent of a BJT device for Fig. S12.

161. Image file “Fig. S13.eps”:

The schematic of the peripheral transistor array and memory array for Fig. S13, draw with Adobe Illustrator.

162. Image file “Fig. S13.png”:

The schematic of the 3D stacking chip for Fig. S13, draw with Blender.

163. Data file “First submission, Fig. 3K, S16A.xlsx”:

20 input data. Each input data with 10 features encoded into input biases *V*ij (j= 1, 2, 3, …, 10).

Fig. S16A is the 3D bar plot for this file.

164. Image file “First submission, Fig. 3K.eps”:

2D mapping plot of the input biases for Fig. 3K in our first submission, draw with Adobe Illustrator.

165. Data file “First submission, Fig. 3L, S16B.xlsx”:

Encoded weights in each device to calculate Score(V).

Fig. S16B is the 3D bar plot for this file.

166. Image file “First submission, Fig. 3L.eps”:

2D mapping plot of the encoded weights for Fig. 3L in our first submission, draw with Adobe Illustrator.

167. Data file “First submission, Fig. 3M.xlsx”:

Binary classification results for the input data in Fig. 3M of our first submission.

168. Image file “First submission, Fig. 3M.eps”:

2D mapping plot of the binary classification results for Fig. 3M in our first submission, draw with Adobe Illustrator.

169. Image file “First submission, Fig. S16A.eps”:

3D bar plot of the input data for Fig. S16A in our first submission, draw with Adobe Illustrator.

170. Image file “First submission, Fig. S16B.eps”:

3D bar plot of the encoded weights for Fig. S16A in our first submission, draw with Adobe Illustrator.

171. Data file “First submission, Fig. S16C-S16D.xlsx”:

The Score(I) and Score(V) for the input data for Figs. S16C-S16D in our first submission.

172. Image file “First submission, Fig. S16C.eps”:

2D line graph of the Score(I) for Fig. S16C in our first submission, draw with Adobe Illustrator.

173. Image file “First submission, Fig. S16D.eps”:

2D line graph of the Score(V) for Fig. S16D in our first submission, draw with Adobe Illustrator.