CLAIMS

1. A non-volatile memory cell comprising:

a storage layer comprised of a ferromagnetic material in which data is recordable as a direction of magnetisation;

a piezomagnetic layer comprised of an antiperovskite piezomagnetic material selectively having a first type of effect on the storage layer and a second type of effect on the storage layer dependent upon the strain in the piezomagnetic layer; and

a strain inducing layer for inducing a strain in the piezomagnetic layer thereby to switch from the first type of effect to the second type of effect.

2. A non-volatile memory cell according to Claim 1, in which the first type of effect is one where a net magnetisation of the piezomagnetic layer is strong enough to overcome the coercive field in the storage layer and for the magnetisation of the storage layer to align with the magnetisation of the piezomagnetic layer through dipolar coupling and the second type of effect is one where any magnetic field in the storage layer due to any magnetisation in the piezomagnetic layer is lower than the coercive field of the storage layer.

3. A non-volatile memory cell according to Claim 1 or 2, further comprising a non-magnetic layer between the storage layer and the piezomagnetic layer for preventing an exchange bias between the storage layer and the piezomagnetic layer.

4. A non-volatile memory cell according to Claim 1, 2 or 3, in which the antiperovskite material has a Neel temperature greater than 350K at a strain of +/- 30%, preferably +/- 10%, most preferably +/- 1%.

5. A non-volatile memory cell according to any preceding claim, in which the antiperovskite piezomagnetic material is Mn_3SnN or Mn_3SnN based such as $Mn_{3-x}A_xSn_{1-y}B_yN_{1-z}$, where A and B are one or more elements selected from the list including: Ag, Al, Au, Co, Cu, Fe, Ga, Ge, In, Ir, Ni, Pd, Pt, Rh, Sb, Si, Sn, Zn.

6. A non-volatile memory cell according to Claim 1, in which the first type of effect is one in which the piezomagnetic layer is in the paramagnetic state and no exchange bias interaction between the storage layer and the piezomagnetic layer is present thereby allowing the direction of magnetisation of the storage layer to be changed by an external magnetic field and

the second type of effect is an exchange bias interaction in which the piezomagnetic material is in the antiferromagnetic state and the direction of magnetisation of the storage layer is pinned by the piezomagnetic layer.

7. A non-volatile memory cell according to Claim 6, in which the antiperovskite piezomagnetic material has a Neel temperature which varies with strain and in which the Neel temperature passes 293K when the strain is varied from + 30% to -30%, preferably + 10% to -10%, most preferably +1% to -1%.

8. A non-volatile memory cell according to Claim 6 or 7, in which the antiperovskite piezomagnetic material is Mn_3GaN or Mn_3NiN, or Mn_3GaN or Mn_3NiN based such as $Mn_{3-x}A_xGa_{1-y}B_yN_{1-z}$ or $Mn_{3-x}A_xNi_{1-y}B_yN_{1-z}$, where A and B are one or more elements selected from the list including: Ag, Al, Au, Co, Cu, Fe, Ga, Ge, In, Ir, Ni, Pd, Pt, Rh, Sb, Si, Sn, Zn.

9. A non-volatile memory cell according to Claim 6, 7 or 8, further comprising at least one additional electrode to apply a magnetic field positioned adjacent the storage layer for changing the direction of a magnetisation of the storage layer.

10. A non-volatile memory cell according to any preceding claim, in which the strain inducing layer is a piezoelectric layer, preferably a perovskite material.

11. A non-volatile memory cell according to any preceding claim, in which the ferromagnetic layer has a perovskite or antiperovskite structure.

12. A non-volatile memory cell according to any preceding claim, further comprising:

a first electrode connected to the storage layer on a side opposite the piezomagnetic layer and a second electrode connected to the strain inducing layer on a side opposite the piezomagnetic layer.

13. A two-dimensional or three-dimensional array of memory cells comprising a plurality of non-volatile memory cells according to any preceding claim in a two-dimensional array or three-dimensional array, respectively.

14. A method of writing data to and reading data from a non-volatile memory cell comprising a storage layer and an antiperovskite piezomagnetic layer, the method comprising the steps of:

inducing a polarisation in a first or second direction in the storage layer thereby to write data to the memory cell, polarisation of the storage layer in the first direction inducing a first magnetic state in the antiperovskite piezomagnetic layer and polarisation of the storage layer in the second direction inducing a second magnetic state in the antiperovskite piezomagnetic layer: and

measuring a magneto-capacitance of the memory cell, the magneto-capacitance of the antiperovskite piezomagnetic layer being different in the first magnetic state than in the second magnetic state, thereby to read the data stored in the storage layer.

15. A method according to Claim 14, in which the measuring comprises applying an alternating voltage across the storage layer and antiperovskite layer and determining the magneto-capacitance of the memory cell via a change of reactance or a shift in resonance frequency of the memory cell.

16. A method according to Claim 14 or 15, in which the storage layer is comprised of a ferromagnetic material or a ferroelectric material and the polarisation is a magnetic polarisation or an electric polarisation respectively.

17. A method according to Claim 16, in which the storage layer is comprised of a ferromagnetic material and the inducing is performed by inducing a magnetisation in the antiperovskite piezomagnetic layer strong enough for the magnetic polarisation of the storage layer to align with the magnetisation of the antiperovskite piezomagnetic layer through dipolar coupling.

18. A method according to Claim 17, in which the non-volatile memory cell further comprises a strain inducing layer and inducing a magnetisation in the antiperovskite piezomagnetic layer is achieved by inducing a strain in the antiperovskite piezomagnetic layer using the strain inducing layer.

19. A method according to Claim 16, in which the inducing comprises inducing a magnetisation in the storage layer using a magnetisation electrode while the antiperovskite piezomagnetic layer is paramagnetic due to an applied strain.