Correlations between crystal structure, microstructure and magnetic properties in FeNi

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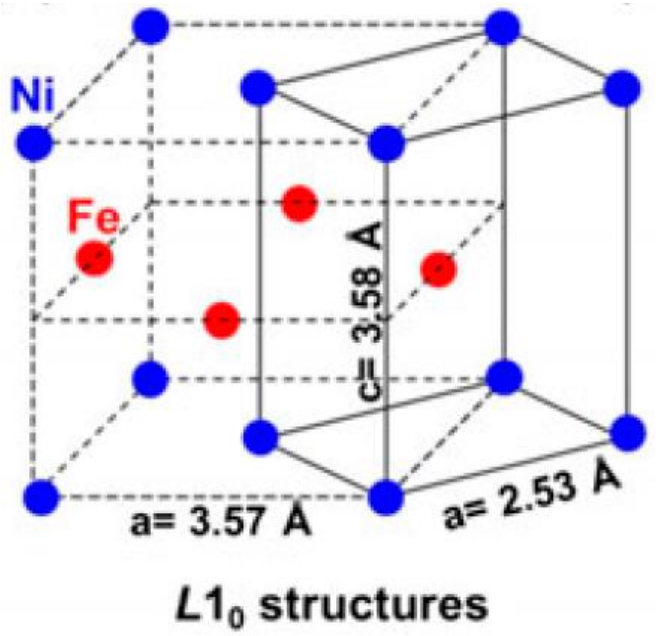
$L1_0$ structure FeNi



$L1_0$ structures

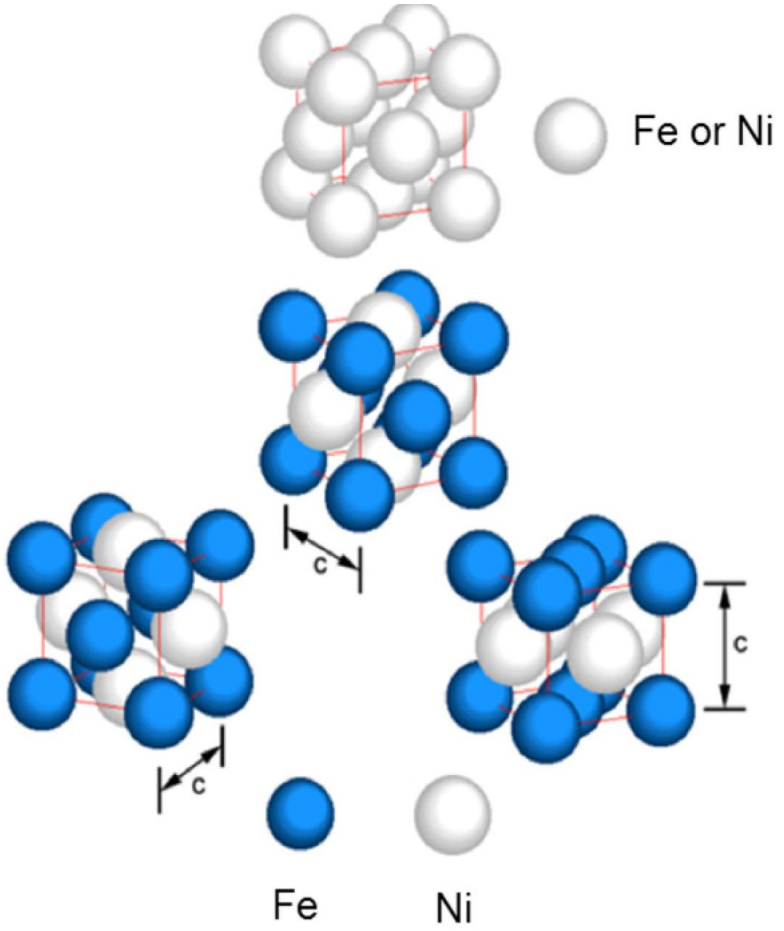
Tetragonal $L1_0$-ordered FeNi/tetrataenite, is a rare-earth-free magnetic compound.

Typical composition range of Ni is from 45 to 55 wt%

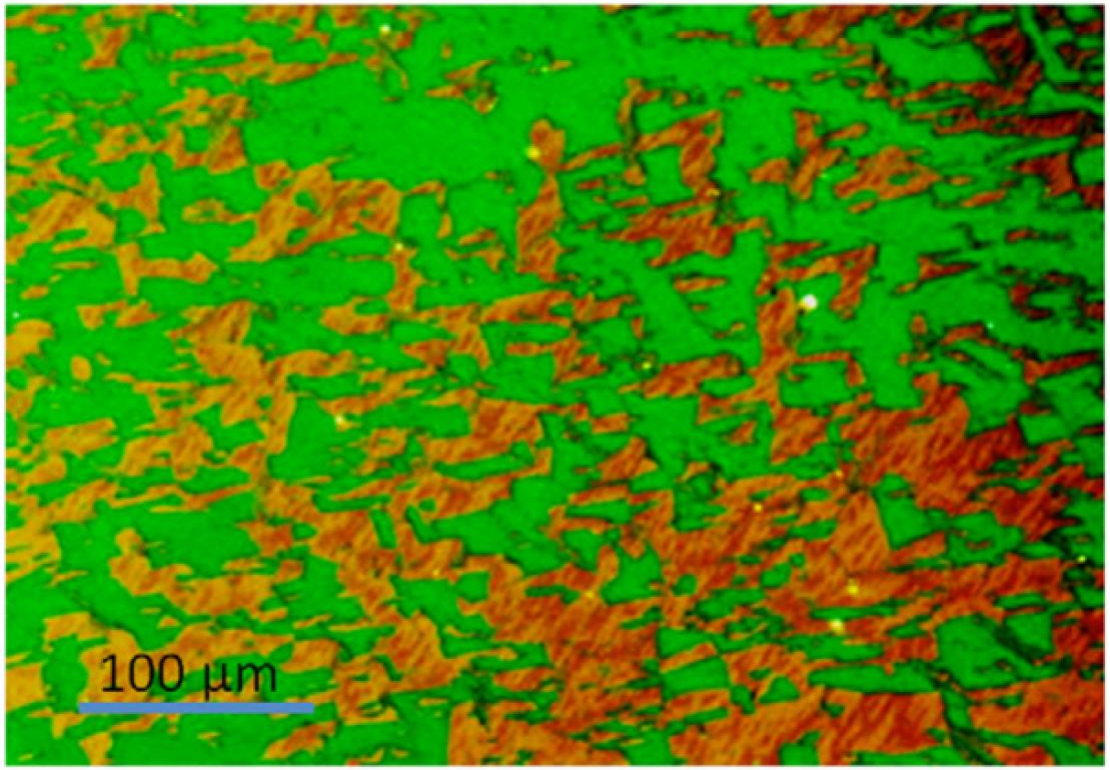
saturation magnetization is 1.6μb/magnetic atom.

The compound naturally occurs in meteorites and requires millions of years to anneal in nature.(one atomic jump per 10 000 years at 300 C)

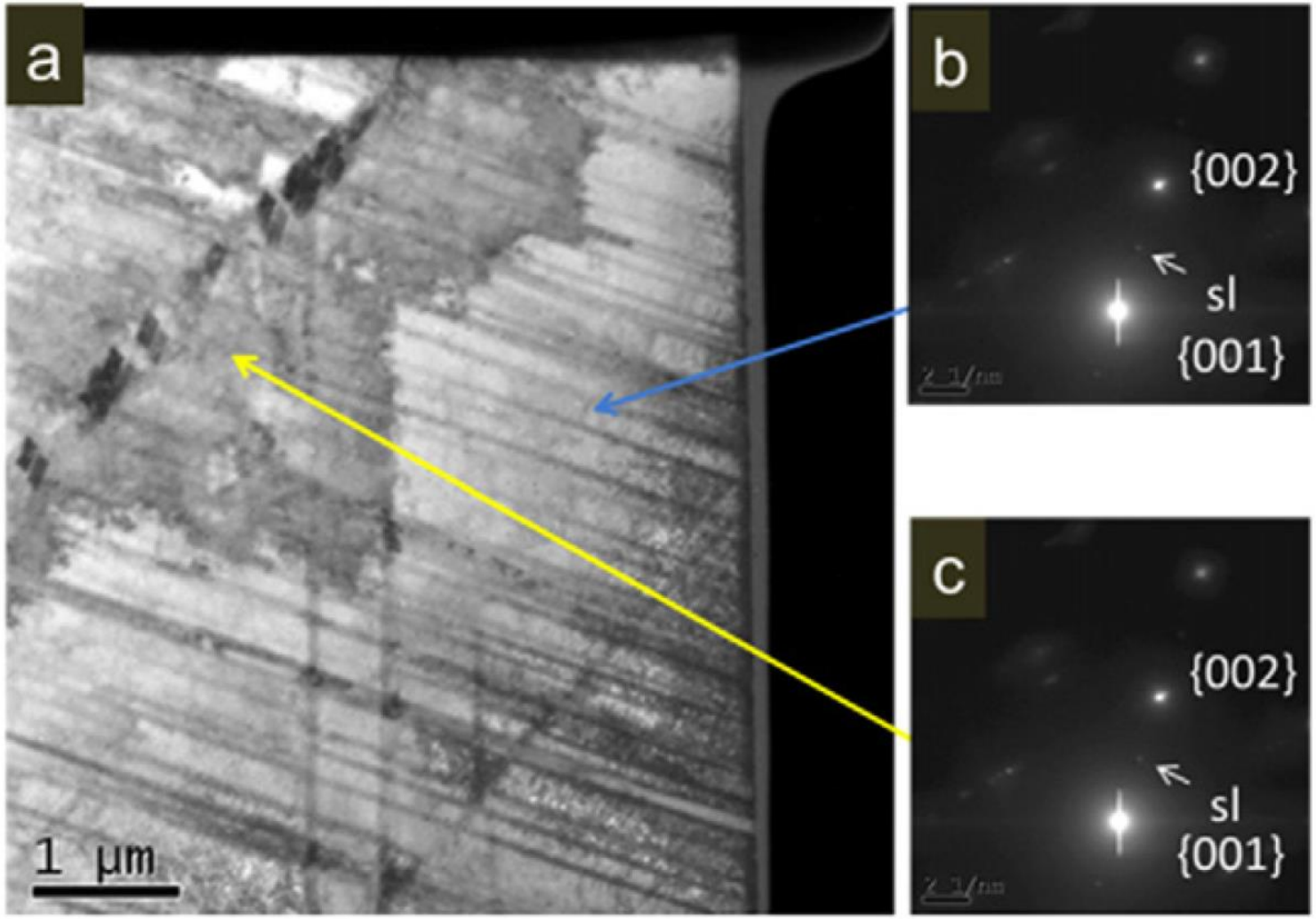
Theoretically magnetocrystalline anisotropy constant can be in the range K_1=0.5–1MJ/m^3.



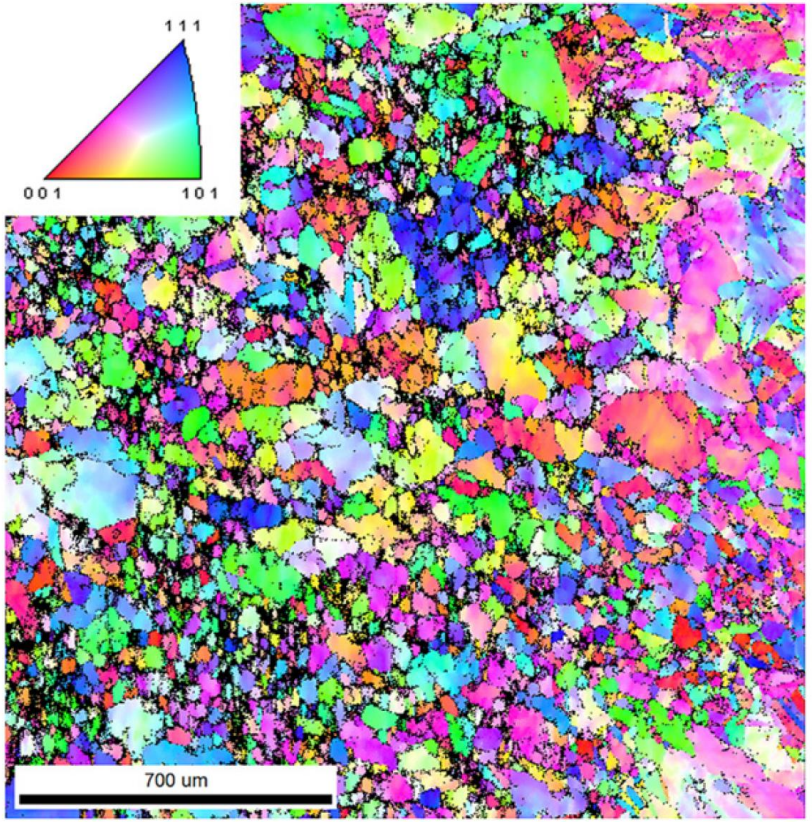
The unit cells of the A1 (top) and $L1_0$ (bottom) phases. The figure shows the three variants of $L1_0$.



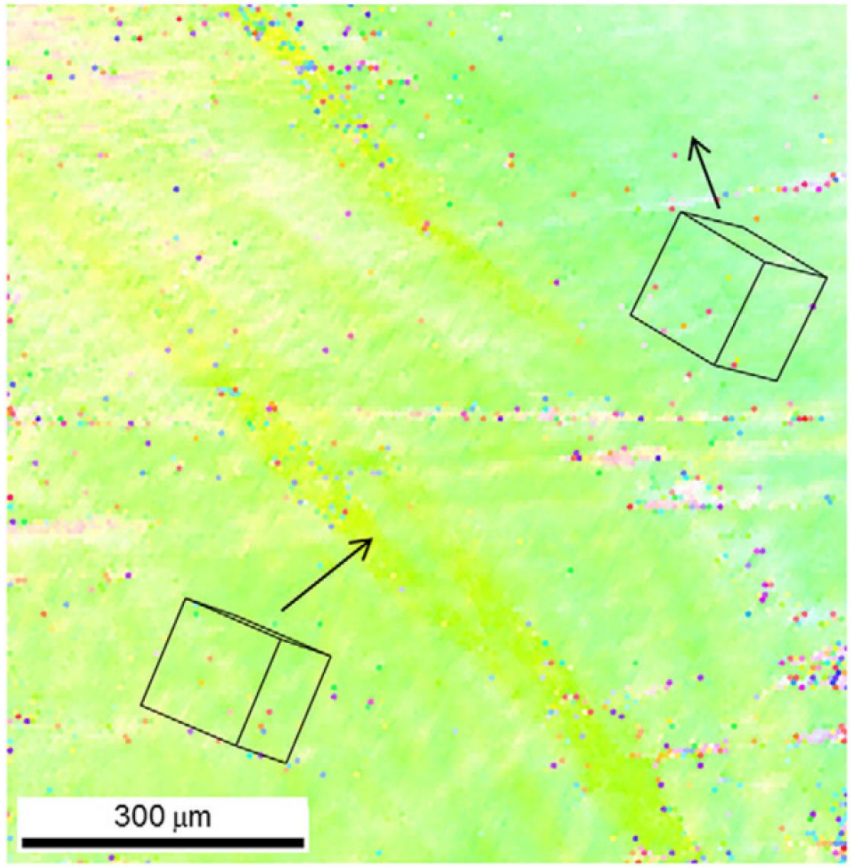
Polarized light microscopy image of the NWA 6259 iron meteorite(FeNi). The two sets of contrast colors (red/orange, light green/dark green) correspond to out of pane and in plane variants.



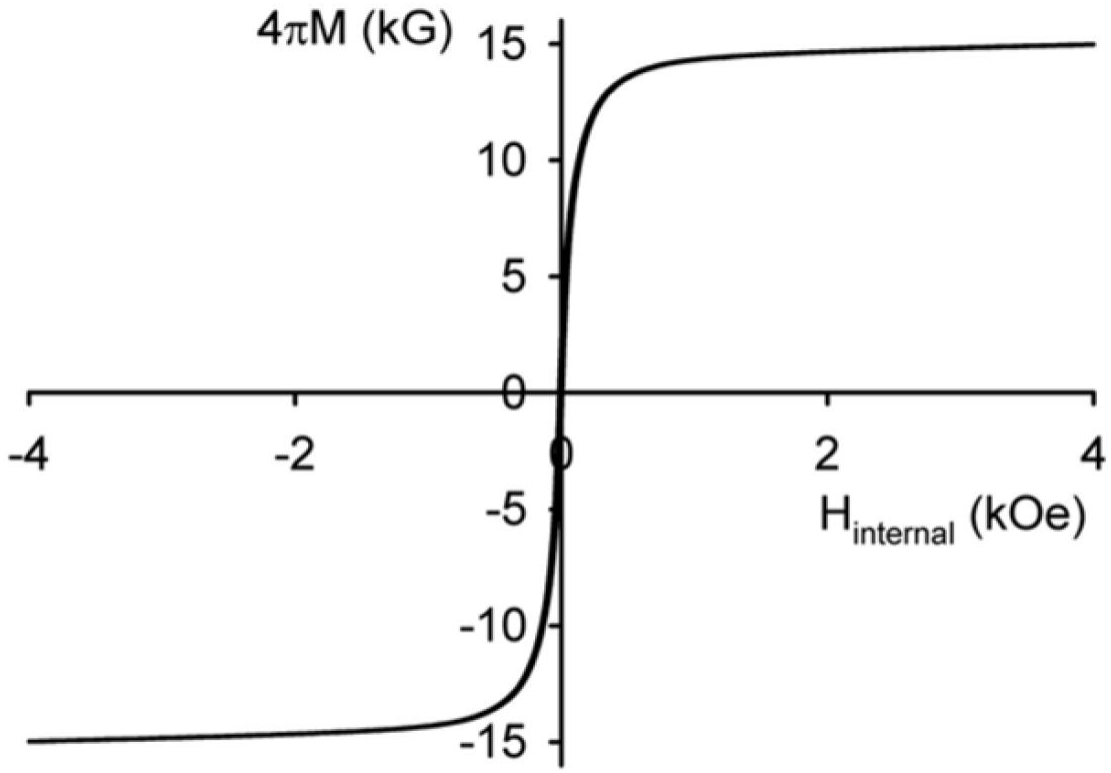
Dark field TEM image of a representative area of the meteorite NWA 6259.
(a) TEM dark field image .
(b). The L10 ordered region appears as a bright area, indicated by the blue arrow.
(c). Another L10 ordered region appears as a dark area, indicated by the yellow arrow



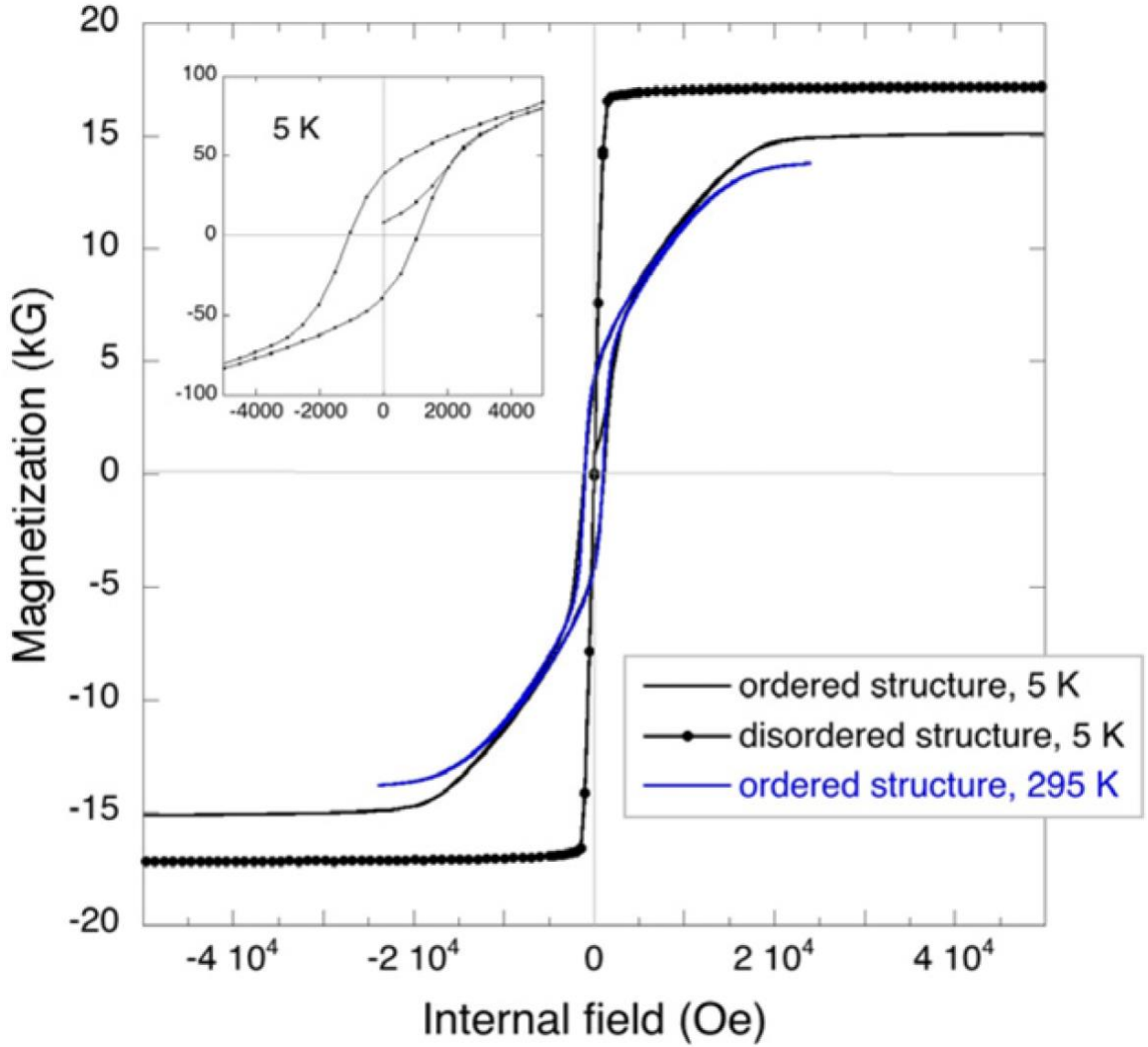
Electron backscattered diffraction data collected from a highly deformed region of the NWA 6259 meteorite sample.



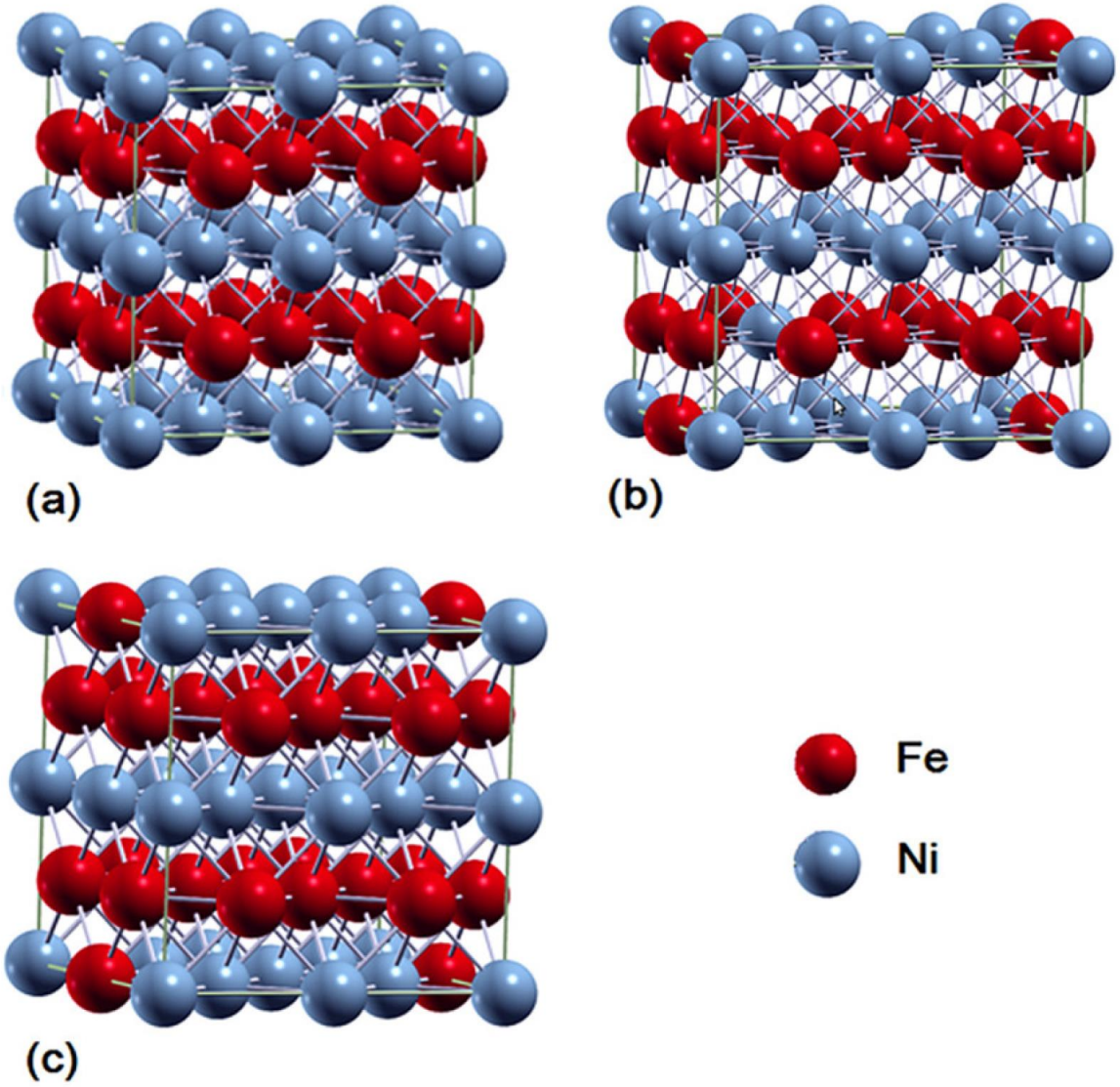
Electron backscattered diffraction data collected from a highly uniform interior region of the NWA 6259 meteorite sample. The cubes indicate the near (101) crystallographic texture.



Soft-magnetic hysteresis loop obtained from the a highly defective/polycrystalline volume.



Hysteresis curves measured at 5 and 295 K of a sample selected from the highly uniform region of meteorite NWA 6259.
The hysteresis curve at 5 K after disordering at high temperature is shown for comparison.
Inset: enlargement ordered structure 5K.



Assumed 32atom supercell structures for: (a) perfect tetrataenite, (b) antisite disorder and (c) one extra Fe atom per supercell. In (c), the stoichiometry is about Fe53Ni47.

	Perfect $L1_0$	Antisite $L1_0$	$Fe_{17}Ni_{15}$
Total moment (μ_B/atom)	1.625	1.620	1.673
Average Fe moment (μ_B)	2.630	2.616	2.604
Average Ni moment (μ_B)	0.619	0.625	0.619

Calculated Fe, Ni and total moments for the FeNi structures

Conclusion

There are three variants of $L1_0$ FeNi in bulk material. It is possible to have three variants in one grain.

Coercivity of meteorite with three variants can be as high as 1200Oe

Engineering to favor a single variant may be necessary.