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Hierarchical structure and strengthening mechanisms in pearlitic steel wire

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Microstructure evolution and strengthening mechanisms have been analyzed in a cold-drawn pearlitic steel wire (the strongest engineering materials in the world) with a nanostructure down to 10 nm and a flow stress up to 5.4 GPa. The interlamellar spacing and the cementite lamellae thickness are reduced during drawing in accordance with the change in wire diameter up to a strain of 2.5. At a higher strain enhanced thinning of cementite lamellae points to decomposition and carbon enrichment of the ferrite lamellae. Dislocations are stored as individual dislocations and in low angle boundaries. No saturation in the dislocation density is observed and it increases to 5E16 m^{-2} at a strain of 5.4. A high dislocation density at the ferrite/cementite(ferrite) interface is also observed. Boundary strengthening, dislocation strengthening and solid solution hardening are suggested and good agreement is found between the calculated flow stresses and experimental values.

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