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Low temperature ordering of high-density FePtCu nanoparticles fabricated by rf-magnetron sputtering

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The $L1_0$-type ordered phase was formed at the low substrate temperature as low as 290°C by rf-magnetron sputtering. These Fe-Pt-Cu nanoparticles were epitaxially grown on the NaCl substrate with orientation relationships as follow: $<011>_{FePtCu} \parallel <011>_{NaCl}$, $\{100\}_{FePt} \parallel \{100\}_{NaCl}$. Clear 001 and 110 superlattice reflections were observed in the corresponding selected area electron diffraction pattern. The mean alloy composition was $Fe_{37}Pt_{52}Cu_{11}$. In spite of the ordering at 290°C, coercivity measured at room temperature was very small, which can be attributed to a very small particle size as small as 6 nm in diameter. The $L1_0$ ordering was promoted in the specimen fabricated at 340°C, resulted in a larger coercivity as large as 1.4 kOe with a mean particle size of 12 nm. The particle size and the particle density were changed between 4 nm and 12 nm, and 0.65 and $2.8 \times 10^{12} cm^{-2}$, respectively depending on the sputtering time at 340°C. In nano-beam electron diffraction, we obtained three kinds of patterns with beam incidence of [100], [010] and [001] with respect to the $L1_0$-structure, indicating the existence of three kinds of orientation in crystallographic c-axes.