Nanomaterials have been extensively studied during the last decades because of their size-, shape-, and composition-dependent properties; leading to practical and potential applications in different fields such as catalysis, plasmonics, medicine, and information storage. Among all the possible material shapes attainable at the nanoscale, the cubic one plays a particular role, as cubic nanoparticles constitute the future building blocks for self-assembled structures. Moreover, by alloying two metals together within a nanoparticle, it enhances the material properties compared to the pure mono-metallic ones due to synergistic effects. Among those bi-metallic alloys, the gold-copper (Au-Cu) and gold-palladium (Au-Pd) systems are particularly attractive for applications because they are fully miscible all over their composition range. Furthermore, those alloys exhibit at low temperatures, some ordered phases $\text{Au}_3\text{Cu}$ ($L1_2$), $\text{AuCu}$ ($L1_0$), $\text{AuCu}_3$ ($L1_2$), $\text{Au}_3\text{Pd}$ ($L1_2$), $\text{AuPd}$ ($L1_0$) and $\text{AuPd}_3$ ($L1_2$), depending on the alloy composition. The chemical ordering is particularly advantageous in catalysis however, the knowledge of the order-disorder temperature transition where those superlattices form is totally unknown at the nanoscale. Therefore, the purpose of this work is to predict theoretically the phase diagram of those ordered phases using nanothermodynamics and to deliver experimental evidence of order-disorder structures through advanced electron microscopy characterization of freshly synthesized Au-Cu and Au-Pd nanocubes.

**Keywords:** Nano-alloys, Phase transitions, Size effect

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