

研究论文

溶液中肼还原钴离子制备纳米金属钴的反应动力学

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摘要 通过加入NaBH₄作为诱导剂,可在室温下引发肼与Co²⁺在水-乙醇体系中的还原反应,制得高纯度纳米金属钴粉.机理研究表明,该反应分二段进行:第一段主要发生Co²⁺被N₂H₄还原的反应(2Co²⁺+N₂H₄+4OH⁻=2Co⁺+N₂+4H₂O),第二段主要为金属Co催化的肼分解反应(N₂H₄=N₂+2H₂)和歧化反应(3N₂H₄=N₂+4NH₃).Co²⁺被N₂H₄还原是典型的自催化过程,因此,加入少量NaBH₄即可在288 K下启动反应.通过测量气体产物的生成速率,获得了Co²⁺还原的反应动力学方程,发现Co²⁺,N₂H₄和产物Co的反应级数分别为1,0和1,反应活化能约为89 kJ/mol.调节Co²⁺的浓度,纳米金属钴的表面积可从11增加到25 m²/g.

关键词 [纳米金属Co](#) [肼还原](#) [反应动力学](#) [自催化反应](#)

分类号

Reaction Kinetics of Reduction of Co²⁺ by Hydrazine in Solution for the Preparation of Cobalt Nanoparticles

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Abstract The cobalt nanoparticles have been prepared by reduction of Co²⁺ with hydrazine in ethanol-aqua system at room temperature. It was found that the overall reaction occurs in two stages. The first stage is the reduction of Co²⁺ by N₂H₄ according to 2Co²⁺+N₂H₄+4OH⁻=2Co⁺+N₂+4H₂O, while the second stage consists of two side reactions, the decomposition of hydrazine (N₂H₄=N₂+2H₂) and the disproportionation of hydrazine (3N₂H₄=N₂+4NH₃) catalyzed by the formed cobalt nanoparticles. The reaction for the formation of cobalt is catalyzed by cobalt as an autocatalytic reaction. Accordingly, a small amount of inducing agent, NaBH₄ can be added to initiate the reaction that can then proceed continuously at 288 K. The kinetic equation of the reaction for the reduction of Co²⁺ by hydrazine has been derived by monitoring the volume of gases evolved versus time. It reveals that the reaction orders with respect to Co²⁺, N₂H₄ and Co are 1, 0 and 1, respectively. Thus, the increase of the initial concentration of Co²⁺ and the amount of inducing agent used accelerate the reaction rate and decrease the consumption of N₂H₄ significantly. The activation energy of the autocatalytic reaction was found to be about 89 kJ•mol⁻¹. Change of initial concentration of Co²⁺ might alter the surface area of Co nanoparticles from 11 to 25 m²/g, corresponding to the particles with average diameters from 60 to 30 nm.

Key words [cobalt nanoparticle](#) [reduction by hydrazine](#) [reaction kinetics](#) [autocatalytic reaction](#)

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