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Systematic study of detonation synthesis of Ni-based nanoparticles

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HIGHLIGHTS

- The spherical nickel-based nanoparticles about 5–30 nm were synthesized by a detonation method.
- The structure feature of the nanoparticles were characterized in detail by TEM, EDX, XRD and XRF.
- The mole ratio of carbon:nickel, loading density, OBs of the precursors are systematic studied.
- The synthetic mechanism of nickel-based nanoparticles were discussed and elaborated.

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ABSTRACT

The nickel-based nanoparticles such as nickel oxide, carbon coated nickel, carbon coated nickel carbide and their mixtures were synthesized by systematically varying the component of explosive precursors and technological parameters. The features of the as-obtained nanoparticles were characterized with TEM, HRTEM, EDX, XRD and XRF. The data from these optimally designed experimental can govern the different types of nickel-based nanoparticles. The formation mechanism during the detonation process were also discussed and analyzed.

1. Introduction

Over the past couples of years, the preparation and characterization of the functional nanomaterials such as oxide, carbon coated metal, carbon coated carbide and their mixtures so on, that containing magnetic metal have attracted great interest because they are promising candidates for many technological applications [1–3], especially for magnetic materials. Among the functional nanomaterials, the nickel-based nanomaterials such as nickel oxide and nickel or nickel carbide/carbon composite nanoparticles, exhibit novel material properties that have attracted considerable interest as a strong candidate for many applications such as catalytic, anomalous electronic, electrochromic coatings, composite anodes for fuel cells/solar cells, chemical (gas) sensing, semiconductor/magnetic materials, energy storage, environmental applications [4–16]. Due to the various applications of the nickel based nanomaterials, many methods for the preparation of nickel based nanoparticles have been applied and developed such as the sol–gel method, spray pyrolysis, surfactant-mediated method, microwave-assisted and liquid oxidation combination method, the catalytic thermal decomposition method, solid–liquid reaction ball milling assisted by ultrasonic wave method, soft-templating method, laser ablation method [17–27].

From the end of the 19th century, readily oxidized ingredients and metals (Mg, Zn, and Al among them) came into use as a component of explosives to increase their fugacity. Otherwise, the incorporation of transition metal ions ingredients as metal sources of explosive precursors came into use for synthesis of metal-based nanomaterials. Since the middle of the 20th century the development of detonation synthesis of nanodiamond [28,29], detonation technique has the advantage of high efficiency, simple and lower energy consumption, which have attracted many scholars' attention. So that the nanodiamond, nitrides, metal oxides, carbide, CNTs and magnetic composites [30–33] have been successively successfully prepared. With the advantage of the simple equipment/process,

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