Available online at www.sciencedirect.com
SCIENCE DIRECT®
Current Opinion in Solid State and Materials Science 8 (2004) 195–202
Current Opinion in Solid State & Materials Science

Manipulation of nanoparticles in supersonic beams for the production of nanostructured materials

P. Piseri [a,c], H. Vahedi Tafreshi [b], P. Milani [a,c,*]

[a] INFM-Dipartimento di Fisica, Universita' di Milano, Via Celoria 16, I-20133 Milano, Italy
[b] NCRC, North Carolina State University, 2401 Research Dr., Raleigh, NC 27695-8301, USA
[c] Centro Interdisciplinare Materiali e Interfacce Nanostrutturati, Universita' di Milano, Via Celoria 16, 20133 Milano, Italy

Abstract

Production and manipulation of nanoparticles in the gas phase is of primary importance for the synthesis of nanostructured materials and for the development of industrial processes based on nanotechnology. In this review we will present and discuss the approach based on the use of aerodynamic focusing methods coupled to supersonic expansions to obtain high intensity cluster beams with a control on nanoparticle mass and spatial distribution. The implication of this techniques for the synthesis of nanostructured materials will be also presented.

Keywords: Nanoparticles; Supersonic beams; Aerodynamic focusing; Nanostructured materials

1. Introduction

As long as a bottom–up approach to nanotechnology is used, a crucial point to be solved for a real technological breakthrough is the possibility to manipulate nanoscale objects [1]. The general term "manipulation" is used here with special reference to the following meanings: (i) the ability to sort the objects in terms of size or geometrical classification; (ii) the ability to control the position and sometimes the velocity of the nanoscale objects. The need for the first ability is due to the fact that most of the available synthetic routes for the production of nanoparticles are not able to produce a perfectly monodisperse population; depending on the specific application a refinement of particle population is often necessary. The second requisite is naturally connected to the fabrication of a class of systems exploiting the peculiar properties of nanoscale objects, namely "nanodevices".

A number of peculiar qualities make the gas-phase approach a very interesting technique for the fabrication of nanostructured systems. Gas-phase synthesis is an old and well developed technique able to produce large quantities of nanoparticles [2–4] with a high level of control of particle physico-chemical properties as phase and composition [*5,**6]. Effective post-synthesis treatments as high temperature annealing [*7,8] and coating [9] have been demonstrated, as well as the compatibility of aerosol methods with the high purity standards of the semiconductor industry [10]. Positioning of gas phase particles on a surface with a resolution in the 100 nm range and smaller has been shown [11] as well as the possibility of micropatterning particle assembled thin films [*12].

Among the gas-phase manipulation strategies, the exploitation of nanoparticle inertial properties are recently gaining an increased interest for the fabrication of nanostructured systems [*13,14]. The conjunction of

* Corresponding author. Address: INFM-Dipartimento di Fisica, Universita' di Milano, Via Celoria 16, I-20133 Milano, Italy. Tel.: +39 02 503 17350; fax: +39 02 503 17482.
E-mail address: pmilani@mi.infn.it (P. Milani).

1359-0286/$ - see front matter
doi:10.1016/j.cossms.2004.08.002