Highly efficient nanoparticle generation in the gas phase by pulsed DC magnetron sputtering in reactive gas admixtures

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Metal nanoparticles and their composites have received an increasing attention in the last few decades due to their unique chemical, physical, mechanical, electrical, and optical properties, resulting from their dimensions, which provide hosts of potential applications in modern technology [1]. In the current work, we present the preparation of various nanoparticles (Ag-, Al-, Ti-, Si-based) by means of a gas aggregation source with pulsed reactive DC magnetron sputtering. Usually, argon was used as a working gas, but in case of reactive materials (Ti, Al, Si) a low concentration of oxygen or nitrogen was admixed, which is necessary for the cluster formation process [2]. It was also shown that a gas aggregation cluster source based on pulsed reactive DC magnetron sputtering gives rise to a huge increase in deposition rate of nanoparticles by more than one order of magnitude compared to continuous operation (e.g., TiO$_x$ nanoparticles) [3]. The above mentioned observation could provide an opportunity for aggregation cluster sources to be more widely utilized in industrial applications. The contribution is focused on the influence of reactive gas (O$_2$, N$_2$) admixtures and pulsed discharge parameters on the formation and deposition of nanoparticles by gas aggregation method. The behaviour of reactive and more noble metals is compared. It is shown that the deposition rate is strongly dependent on duty cycle and discharge repetition frequency. The prepared nanoparticles were characterized with regard to chemical composition, morphology and optical properties.


Keywords
Nanoparticles
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