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Electrophoretic deposition of graphene-related materials: A review of the fundamentals

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ABSTRACT

The Electrophoretic Deposition (EPD) of graphene-related materials (GRMs) is an attractive strategy for a wide range of applications. This review paper provides an overview of the fundamentals and specific technical aspects of this approach, highlighting its advantages and limitations, in particular considering the issues that arise specifically from the behaviour and dimensionality of GRMs. Since obtaining a stable dispersion of charged particles is a pre-requisite for successful EPD, the strategies for suspending GRMs in different media are discussed, along with the resulting influence on the deposited film. Most importantly, the kinetics involved in the EPD of GRMs and the factors that cause deviation from linearity in Hamaker's Law are reviewed. Side reactions often influence both the efficiency of deposition and the nature of the deposited material; examples include the reduction of graphene oxide (GO) and related materials, as well as the decomposition of the suspension medium at high potentials. The microstructural characteristics of GRM deposits, including their degree of reduction and orientation, strongly influence their performance in their intended function. These factors will also determine, to a large extent, the commercial potential of this technique for applications involving GRMs, and are therefore discussed here.

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Contents

1. Introduction

Graphene-related materials (GRMs), including graphene, few layered graphene (FLG), graphene oxide (GO) and reduced graphene oxide (rGO), are multifunctional nanostructured building blocks with extraordinary properties which may contribute to many fields of science and technology [1]. However, in order to exploit GRM properties for the production of functional devices, controlled processing methods are essential. Electrophoretic deposition (EPD) is an attractive technique for manipulation and deposition of nanomaterials, in general, and also for GRMs specifically. The process parameters can be easily manipulated to adjust the chemical and morphological conformation of the deposit with considerable flexibility [2,3]. EPD in its simplest form requires the application of