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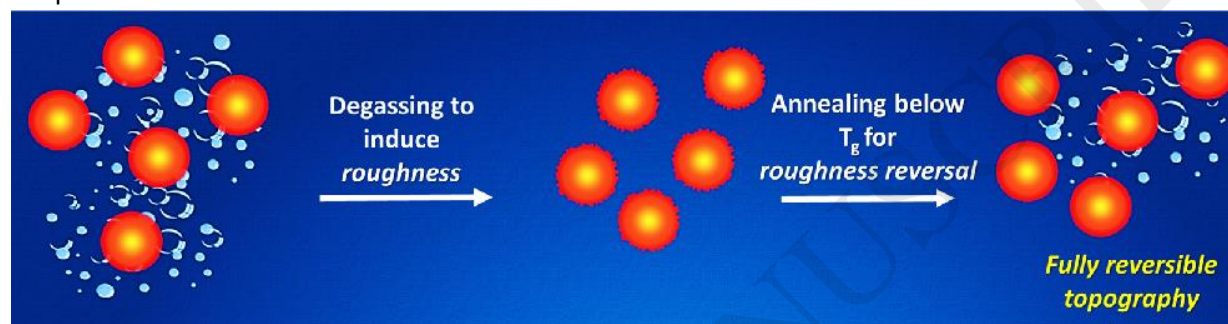
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A Method for Reversible Control over Nano-Roughness of Colloidal Particles

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Graphical abstract



Abstract

Colloidal particles often display a surface topography that is smooth down to the nanometer scale. Introducing roughness at this length scale can drastically change the colloidal interactions, adsorption at interfaces and bulk flow behavior. We report on a novel, simple method to induce and control nano-scale roughness on (water based) polymer latex colloids. Reducing the amount of dissolved gases in the aqueous phase from the electrolyte solution surrounding the particles, generates self-structured surface asperities with an amplitude that can be tuned via temperature and repetition of the treatment. Due to the viscoelastic nature of the polymeric asperities, a mild thermal treatment below the glass transition temperature can be used for nanostructure relaxation, so that the particles can recover their original topography, making this method fully reversible. Roughness can thus be controlled without affecting the chemical composition of the colloidal surface. Experiments for varying particle size, polymer type and surface chemistry suggest a broad applicability of our method.

Keywords: colloids, polymer latex, polystyrene, surface roughness, degassing, thermo-reversible

1. Introduction

Particles with controlled surface roughness are important for both fundamental science and industrial applications. Introducing (or enhancing) surface heterogeneity on colloids has major outcomes for such systems, especially for the interactions between the particles. When two colloids come close together the thermodynamic (e.g. electrostatic, van der Waals) forces will be strongly modified due to the presence of the asperities (or pits) [1-3]. In the presence of non-adsorbing polymers that fit in the nano-scale surface cavities of the rough particles, attractive depletion forces between the colloids will be strongly altered as well [4]. Particle interactions induced by (shear) flow can also be strongly modified by surface roughness. For example, short-ranged hydrodynamic forces will change because of alterations in the lubrication film thickness [5]. If the particles approach each other even closer to the point of direct contact, friction forces come into play. These forces generally depend strongly on surface topology,

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