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Pattern formation of gold-PVA nanomix spin coated on different substrates

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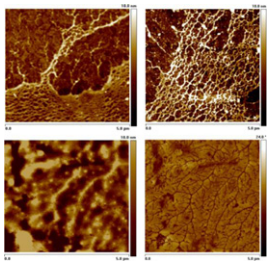
HIGHLIGHTS

- Au nanoparticles/PVA mixtures self assemble and form different patterns.
- Au particle size has an effect of disintegration of PVA molecules.
- Patterns formed are duly reproduced using Monte Carlo simulations.
- Pattern formation are explained by on spinodal dewetting or fingering instability mechanisms.

GRAPHICAL ABSTRACT

AFM images showing pattern formation after deposition of Au 6 nm in PVA mix at different PVA concentrations on ITO substrates



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ABSTRACT

The patterns arising from the interplay of colloidal gold nanoparticles solutions containing polyvinyl alcohol spin coated on different substrates have been investigated. High Resolution Transmission Electron Microscope results show chain-like assemblies and direct attachment of spherical shape gold nanoparticles with different size in the polyvinyl alcohol matrix. X-ray photoelectron spectroscopy analysis of the C 1s peak shows three different Au-polyvinyl alcohol bands (—CH_2, C—OH and C=O) which accounts for the effect of the Au particle size in the gold-PVA films. Dewetting of indium tin oxide substrates by 6 nm Au nanoparticles/polyvinyl alcohol colloidal solution induces concentration dependent cellular structures and fingering instability patterns which were duly reproduced using Monte Carlo simulations. Our results ascertain the importance of nanoparticle size, substrate type, oriantation and surface roughness on the pattern formation. In addition, we demonstrate that pattern formation on different substrates takes two different routes based on nanoparticle mobility rate, evoparation chemical potential and nanoparticle density.

1. Introduction

Noble metal nanoparticles (NPs) have received a great attention in recent years due to their profound applications in various fields of science. Inherent properties of these particles depend merely on their size, shape, composition and crystallanity [1]. Their assembly into well defined structures has been widely investigated after spin coating of their colloidal solutions on planar substrates. These solutions wet the substrates and start to evaporate and eventually form films which show patterns of different shapes and sizes. Factors like nanoparticle diffusion, concentration, evaporation conditions, film thickness, frictional forces, chemical potential, temperature as well as liquid–liquid, nanoparticle–nanoparticle, nanoparticle–liquid, nanoparticle–substrate and liquid–substrate

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