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# Fabrication and tribological properties of polyelectrolyte multilayers containing in situ gold and silver nanoparticles

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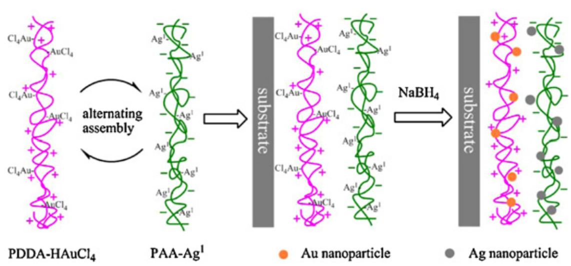
## HIGHLIGHTS

- ▶ Au and Ag nanoparticles were synthesized by in situ reduction.
- ▶ PEMs were prepared by layer-by-layer and in situ reduction methods.
- ▶ PDDA–Au/PAA–Ag PEMs possesses a lower friction coefficient.
- ▶ PDDA–Au/PAA–Ag PEMs has longer anti-wear life than the pure PEMs.

## GRAPHICAL ABSTRACT

Schematic of the layer-by-layer buildup and gold and silver nanoparticles formation process.

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## ABSTRACT

Gold and silver nanoparticles in polyelectrolyte multilayers film can be prepared by alternate immersion of a substrate in poly(diallyldimethylammonium) chloride (PDDA)–$AuCl_4^-$ complexes solution and poly(acrylic acid) (PAA)–$Ag^+$ complexes solution followed by reduction of the metal cations ($Au^{3+}$, $Ag^+$) through immersion of $NaBH_4$ solution. UV–vis spectroscopy, atomic force microscopy (AFM), X-ray photoelectron spectra (XPS), scanning electron microscope (SEM) and transmission electron microscope (TEM) were used to confirm the successful construction of the polyelectrolyte multilayers film and the formation of gold and silver nanoparticles. The coefficient of friction as a function of sliding velocity and normal load also has been studied. The nanoparticles composite polyelectrolyte multilayers exhibited increased wear resistance compared with the pure polyelectrolyte multilayers.



## 1. Introduction

The layer-by-layer construction of polyelectrolyte multilayers (PEMs) has been extensively studied over the previous decade which has been invented by Decher and co-workers [1–3]. The layer-by-layer molecular deposition process, which can be achieved by the sequential adsorption of polyelectrolytes on a charged surface leads to surface charge reversal and it can be used to modify a surface with vastly different properties to those of the underlying substrates [4]. This is, in no small part, due to the vast potential and utility of such uniform thin films in applicable areas for photonic devices [5], chemical sensors [6], capsules [7] and electrical devices [8]. The popularity of this molecular deposition procedure is due to its simplicity, versatility and systematical control over the structure and the thickness of the resulting films. Moreover, the materials used in layer-by-layer molecular deposition studies can be small organic molecules [9] or inorganic compounds [10], biomacromolecules such as proteins and DNA [11,12], or even colloids [13].

Nanoparticles composite ultrathin film has attracted a wide attention due to the various properties of nanoparticles [14].

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