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# Preparation and Evaluation of Nanocomposite LDPE Films Containing Ag and ZnO for Food-Packaging Applications

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**Abstract.** Nanocomposite polymer films were produced from composites comprising LDPE /nanosilver and LDPE/nano-ZnO by melt compounding. The mechanical properties of the films prepared were characterized by using stress-strain analysis. Dispersion quality of nanomaterials into the polymer matrix film was monitored using the Transmission Electron Microscopy. The results showed the nanocomposites as possessing lower elongation at break and more antimicrobial activity with the increase of each of nanofillers content.

## Introduction

Nanocomposites are a novel class of composite materials that have received special attention because of their improved properties at very low loading levels compared with conventional filler composites [1]. Antimicrobially active packaging is a new generation of nano food packaging based on metal nanocomposites which are made by incorporating metal nanoparticles into polymer films [2]. Gajjar et al. [3] reported that nanoparticels (NP) of Ag and ZnO are being used industrially for several purposes. ZnO has found many applications in daily life [4], due to its strong antimicrobial effect on a board spectrum of microorganisms [5]. Moreover, according to Jin et al. [6] reports, it is currently listed by FDA as a generally recognized as safe (GRAS) material. Silver has also been long known to have microbial inhibition [7]. Appendini & Hotchkiss [8] showed that several methods are generally used to produce antimicrobial polymer nanocomposites. They reported that because of the thermal stability of metal nanoparticles and the thermal processing method used for producing the LDPE film as a contacting juice layer in the package, melt mixing is a good approach for this nanocomposite. The main objectives of this study is to evaluate the properties of ZnO and Ag nanoparticles filled LDPE films as a new antimicrobial nanocomposite to use in food packaging.

## Experimental

**Preparation of antimicrobial nanocomposite films.** Film grade LDPE resin pellets (LF0200, MFI 2 g/10 min, density 0.92g/ml, softening point 94$^{o}$C) and antimicrobial agents including P105 powder ($TiO_2$ 95% + metal nanosilver 5% with particle diameters of about 10 nm) and ZnO nanoparticle powder with an average particle diameter of about 70 nm were obtained from Pars Nanonasb Tehran, Iran. Film grade LDPE resin pellets (0.9 Kg) were directly mixed with each of the antimicrobial agents (P105 and nano-ZnO particles) (0.1 Kg) separately and the mixture was fed into a twin-screw extruder machine (Cincinnati Milacron, Batavia, OH) with a screw diameter of 55 mm and a screw length/diameter ratio of 30 mm to be cut into masterbatch nano-granules. The mass fraction of the filler for each antimicrobial agent was 10%. The heating profile was set to six heating zones of the twin-screw extruder including 160$^{o}$C, 160$^{o}$C, 175$^{o}$C, 150$^{o}$C, 150$^{o}$C, and 140$^{o}$C. Proper amounts of masterbatch resins were then added to pure LDPE resin pellets into a single-screw blowing machine with a screw diameter of 45 mm and a length/diameter ratio of 28 mm (Venus Plastic Machinery, Taiwan) to fabricate the final nanocomposite film (50 μm thick) with the