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Influence of Precursor Concentration and Temperature on the Formation of Nanosilver in Chemical Reduction Method

(Pengaruh Kepekatan Pelopor dan Suhu terhadap Pembentukan Nanoargentum dalam Kaedah Pengurangan Kimia)

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ABSTRACT

Nanosilver particles (NSPs) were produced by the reduction of silver nitrate using glucose as reducer, poly (vinyl pyrrolidone) as stabilizer and sodium hydroxide as reaction enhancer. Two parameters were investigated which are silver nitrate concentration (0.1 M, 0.5 M and 1.0 M) and reaction temperature (60°C and 80°C). Through spectral analysis using ultraviolet-visible spectrophotometer (UV-vis), all the samples recorded the maximum peak in the range of 384-411 nm which verified the formation of NSPs. TEM images showed the nanoparticles have spherical shape with the size range of 25-39 nm. Particle size and zeta potential analysis recorded the hydrodynamic size of nanoparticles in the range of 85-105 nm and the zeta potential ranging from -25 to -30 mV, under the pH value of 8. X-ray diffraction analysis showed that the NSPs have face center cubic (FCC) structure. All the produced NSPs surprisingly showed ferromagnetic-like behaviour based on the magnetization curves. FTIR result confirmed the presence of poly (vinyl pyrrolidone) on the NSPs surface. Furthermore, at the reaction temperature 60°C, the crystallite size, physical size as well as hydrodynamic size increased as the precursor concentration increased from 0.1 M to 0.5 M. However, as the precursor concentration further increases to 1.0 M, the size become smaller due to incomplete reduction process. In contrast, at 80°C, the sizes was gradually increased as the precursor concentration increases up to 1.0 M. In terms of controlled precursor concentration, the crystallite size and physical size become smaller as the temperature increases.

Keywords: Chemical reduction; nanosilver; precursor concentration; reaction temperature

ABSTRAK

Zarah nanoargentum (NSPs) telah dihasilkan oleh pengurangan argentum nitrat menggunakan glukosa sebagai pengecil, poli (vinil pirolidon) sebagai penstabil dan natrium hidroksida sebagai penggalak tindak balas. Dua parameter yang dikaji merangkumi kepekatan argentum nitrat (0.1 M, 0.5 M dan 1.0 M) dan suhu tindak balas (60°C dan 80°C). Melalui analisis spektrum menggunakan sinar ultra-ungu boleh nampak spektrofotometer (UV-vis), puncak maksimum kesemua sampel direkodkan dalam lingkungan 384-411 nm yang mengesahkan pembentukan NSPs. Imej-imej TEM menunjukkan nanozarah mempunyai bentuk sfera dengan julat saiz 25-39 nm. Analisis saiz zarah dan zeta potential mencatatkan saiz hidrodinamik nanozarah dalam lingkungan 85-105 nm dan zeta potential meliputi -25 hingga -30 mV, di bawah nilai pH 8. Analisis pembelauan sinar-X mendedahkan bahawa NSPs mempunyai struktur face center cubic *(FCC). Tanpa dijangka kesemua NSPs yang dihasilkan menunjukkan kelakuan seperti feromagnetik berdasarkan lengkung pemagnetan. Transformasi Fourier inframerah spektrometer (FTIR) mengesahkan kehadiran poli (vinil pirolidon) di permukaan NSPs. Tambahan pula, pada suhu tindak balas 60°C, saiz kumin hablur, saiz fizikal serta saiz hidrodinamik meningkat apabila kepekatan pelopor meningkat daripada 0.1 M ke 0.5 M. Walau bagaimanapun, apabila kepekatan pelopor terus meningkat kepada 1.0 M, saiz menjadi lebih kecil disebabkan proses pengurangan tidak sempurna. Sebaliknya, di 80°C, saiz beransur-ansur meningkat apabila kepekatan pelopor meningkat sehingga 1.0 M. Daripada segi kepekatan pelopor yang terkawal, saiz kumin hablur dan saiz fizikal menjadi lebih kecil apabila suhu bertambah.*

Kata kunci: Kepekatan pelopor; nanoargentum; pengurangan kimia; suhu tindak balas

INTRODUCTION

Metal nanostructures especially nanosilver particles (NSPs) have gained enormous attention among researchers and have been exploited in a wide range of applications due to their interesting features such as bactericidal action, improved catalytic activity, unique optical properties, high electrical conductivity (Li et al. 2010) and high resistance to oxidation (Nersisyan et al. 2003) as compared to the conventional silver. These NSPs commonly incorporated into products such as purification system (water and air), conductive applications (touch screen and high-intensity LEDs) and optical applications (solar cells and surface plasmonic devices).

Various methods have been developed by the previous researchers in synthesizing NSPs and among the methods, chemical reduction is the most preferable in obtaining