Synthesis Of Silver Nanoparticles Under The Influence Of Various Reducers

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Annotation
In this study, the synthesis of silver nanoparticles (AgNZ) with the participation of various reducing agents was studied. Silver nanoparticles have antibacterial, optical and biocompatible properties. The nature, concentration of reducing agents and the role of stabilizers in their synthesis are of great importance. In the study, silver nanoparticles were synthesized using $AgNO_3$ based on sodium citrate, hydrazine and glucose, and gelatin was used as a stabilizer. The resulting nanoparticles were confirmed by UV–Visible spectrum (peak 421 nm) and XRD analysis. Sodium citrate was identified as the most effective reducing agent. This method is an environmentally friendly, effective and economically viable solution.
Keywords: silver nanoparticles, $AgNO_3$, reducing agents, sodium citrate, glucose, hydrazine, gelatin, UV–Visible spectrum, XRD analysis, antibacterial properties.
Annotatsiya
Mazkur tadqiqotda turli xil qaytaruvchilar ishtirokida kumush nanozarrachalar (AgNZ) sintezi o‘rganildi. Kumush nanozarrachalar antibakterial, optik va biomoslashuvchan xususiyatlarga ega. Ularni sintez qilishda qaytaruvchi moddalarning tabiati, konsentratsiyasi va barqarorlashtiruvchilarning roli muhim ahamiyat kasb etadi. Tadqiqotda $AgNO_3$ asosida natriy sitrat, gidrazin va glyukoza yordamida kumush nanozarrachalar sintez qilindi, jelatin esa barqarorlashtiruvchi sifatida qo‘llanildi. Hosil bo‘lgan nanozarrachalar UV–Ko‘rinadigan spektr (421 nm cho‘qqi) va XRD tahlillari orqali tasdiqlandi. Natriy sitrat eng samarali qaytaruvchi sifatida aniqlandi. Bu usul ekologik xavfsiz, samarali va iqtisodiy jihatdan maqsadga muvofiq yechimdir.
Kalit so‘zlar: kumush nanozarrachalar, $AgNO_3$, qaytaruvchi moddalar, natriy sitrat, glyukoza, gidrazin, jelatin, UV–Ko‘rinadigan spektr, XRD tahlili, antibakterial xossalar.

Nanotexnologiya zamonaviy fan va texnikaning eng muhim yo‘nalishlaridan biri bo‘lib, turli sohalarda — tibbiyot, ekologiya, energetika, qishloq xo‘jaligida — keng qo‘llanilmoqda. Nanozarrachalar o‘zining o‘ziga xos fizik-kimyoviy xususiyatlari, xususan, kichik o‘lcham, katta sirt maydoni, optik va antibakterial faolligi bilan ajralib turadi.
Kumush nanozarrachalari (AgNZ) ayniqsa antibakterial faolligi tufayli diqqat markazida. Ammo ularning hosil bo‘lish mexanizmi, morfologiyasi va xossalari sintez sharoitlari, ayniqsa qaytaruvchi moddalarga bevosita bog‘liq. Shu sababli kumush nanozarrachalarini turli qaytaruvchilar yordamida sintez qilish muhim ilmiy masalalardan biridir.
Tadqiqotda asosiy modda sifatida kumush nitrat ($AgNO_3$) tanlandi. Qaytaruvchilar sifatida natriy sitrat, glyukoza va gidrazin, barqarorlashtiruvchi sifatida esa jelatin qo‘llanildi. 20°C haroratda 2% va 5% li jelatin eritmalari tayyorlandi. 500 mg/ml li $AgNO_3$ eritmasi bilan birgalikda 0.1 M konsentratsiyadagi qaytaruvchilar eritmalari aralashtirilib 6 xil namuna tayyorlandi. Sintez jarayonida quyidagi kimyoviy reaksiyalar sodir bo‘ldi:

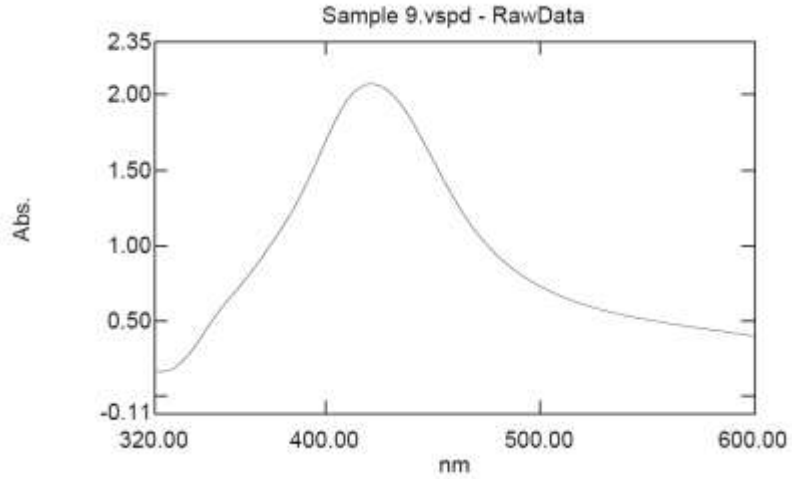
$2Ag^+ + 2OH^- + C_6H_{12}O_6 \rightarrow Ag^o\downarrow + C_6H_{12}O_7 + H_2O$

$12AgNO_3 + 4Na_3C_6H_5O_7 + 6H_2O \rightarrow 12\ Ag^o\downarrow + 12NaNO_3 + 4C_6H_8O_7 + 3O_2.$

$2Ag^+ + 2OH^- + N_2H_4 \rightarrow Ag^o\downarrow + N_2 + H_2O$

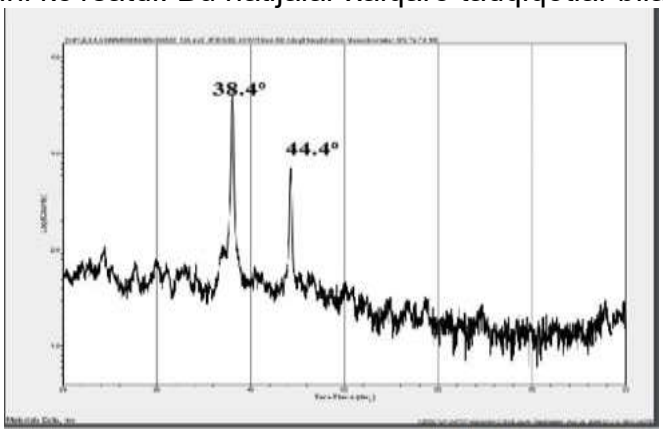
Hosil bo‘lgan eritmalar rangining ochdan to‘q kulrang yoki jigarrang tusga o‘tishi nanozarrachalar hosil bo‘lganligidan dalolat beradi. Rang intensivligining ortishi zarracha o‘lchamining kattalashganini ko‘rsatadi.

Natijalar va muhokama. AgNZ sintez qilingan namunalar UV–Ko‘rinadigan spektr (UB-KN) tahlili bilan o‘rganildi. 421 nm da kuzatilgan cho‘qqi yuzaki plazmon rezonansiga (SPR) mos keladi va kumush nanozarrachalar hosil bo‘lganligini tasdiqlaydi (1-rasm).



1-rasm. AgNZ larning UB spektri.

XRD tahlil natijalariga ko‘ra, 2θ = 38,4° (111) va 44,4° (200) da aniqlangan cho‘qqilar Ag kristall tuzilmasining mavjudligini ko‘rsatdi. Bu natijalar xalqaro tadqiqotlar bilan mos keladi (2-rasm).



2-rasm. AgNZ larning XRD spektri

Turli qaytaruvchilar ta’sirida nanozarrachalar o‘lchami va shakli sezilarli farq qiladi:

- Natriy sitrat bilan sintez qilinganda zarrachalar bir xil hajmda va sferik shaklda bo‘ldi.
- Glyukoza yordamida sintez qilingan AgNZ o‘lchami kichikroq (~20 nm).
- Gidrazin esa katta hajmli, olti burchakli zarrachalar hosil qildi.

Kuchli qaytaruvchilar (masalan, gidrazin) tezroq reaksiyaga kirishib, yirik zarrachalarni hosil qiladi; kuchsizroq qaytaruvchilar (glukoza, natriy sitrat) esa kichikroq va barqarorroq nanozarrachalar beradi.

Sintez natijalari shuni ko‘rsatadiki, kumush nanozarrachalarning morfologiyasi va dispersligi qaytaruvchining kimyoviy tabiati va konsentratsiyasiga bevosita bog‘liq.

1. Jelatin barqarorlashtiruvchi sifatida zarrachalarning aglomeratsiyasini kamaytiradi, ularni kolloid holatda uzoq muddat saqlanishini ta’minlaydi.

2. Natriy sitrat eng optimal natija bergan qaytaruvchi sifatida tanlandi — u ekologik xavfsiz, zaharsiz va iqtisodiy jihatdan tejamli.

Xulosa

1. $AgNO_3$ asosida turli qaytaruvchilar (natriy sitrat, glyukoza, gidrazin) ishtirokida kumush nanozarrachalar sintezi muvaffaqiyatli amalga oshirildi.
2. Nanozarrachalarning hosil bo‘lishi eritma rangining o‘zgarishi, UV–Ko‘rinadigan spektrda 421 nm cho‘qqi va XRD tahlil natijalari bilan tasdiqlandi.
3. Natriy sitrat yordamida sintez qilingan AgNZlar eng barqaror va bir xil hajmli bo‘lib chiqdi.
4. Ushbu yondashuv ekologik xavfsiz, iqtisodiy va samarali bo‘lib, tibbiyot, ekologiya va sanoat sohalarida qo‘llanishi mumkin.

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