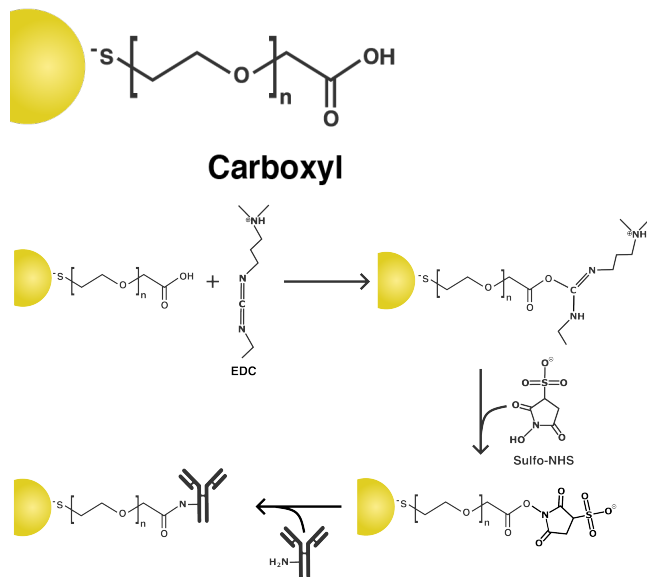


PRODUCT DATA SHEET

Carboxylated Silver Nanoparticles



Description

Cytodiagnostics carboxylated silver nanoparticles are available with two different lengths of PEG surface spacers, i.e. 3000Da and 5000Da offering control of particle hydrodynamic size.

These functionalized nanoparticles are ideal for conjugation of proteins using standard EDC/NHS coupling chemistry, see page 2 for a recommended protocol.

Our carboxylated silver nanoparticles are available in 8 different sizes ranging from 10 -100nm, are more than 95% spherical and have uniform size distribution (CV <18%).

For custom sizes, formulations or bulk quantities please contact our customer service department.

Features

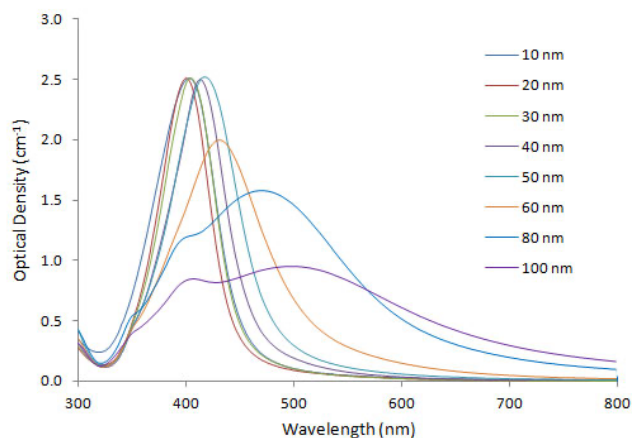
- Superior size distribution compared to the leading competitor; available from 10nm to 100nm.
- Precisely engineered surface with an optimized carboxyl group density for easy conjugation.

Applications

- Ideal for development of silver conjugates for use in applications such as blotting, lateral flow assays, LSPR assays, light microscopy, and transmission electron microscopy (TEM) among others.

Characteristics

Core diameter: 10 -100nm (Coefficient of Variance < 18%)
 Polydispersity Index (PDI): < 0.25
 Concentration: ~0.02mg/ml
 Absorbance (λ_{max}): 390-490nm
 Nr of carboxyl groups on surface: ~ 1/nm²
 Supplied in ddH₂O



Storage

This product should be stored at 4°C. **DO NOT FREEZE.** If stored as specified, Cytodiagnostics Carboxylated Silver Nanoparticles are stable for at least 4 months.

Handling

When stored for a long period of time silver nanoparticles may sediment at the bottom of the vial, which is especially true for larger particle sizes. Prior to use, re-suspend the sedimented particles by swirling until a homogenous solution is obtained.

Precautions and Disclaimer

These products are for R&D use only, not for drug, household, or other uses. Please consult the Material Safety Data Sheet available online at www.cytodiagnostics.com for information regarding hazards and safe handling procedures.

Diameter (nm)	Peak Wavelength (nm)	SPR	NPS/ml	Wt. Conc. (mg/ml)	Size Dispersity (+/-nm)	Particle Volume (nm ³)	Surface Area (nm ²)	Surface/Volume Ratio	Particle Mass (g)	Molar Mass (g/mol)	Molar Conc.
10	390-405		~1.8E+14	2.00E-02	<18%	5.24E+02	3.14E+02	0.6	5.49E-18	3.31E+06	2.99E-07
20	390-410		~2.3E+13	2.00E-02	<15%	4.19E+03	1.26E+03	0.3	4.39E-17	2.65E+07	3.82E-08
30	400-410		~7.0E+12	2.00E-02	<15%	1.41E+04	2.83E+03	0.2	1.48E-16	8.93E+07	1.16E-08
40	405-425		~2.8E+12	2.00E-02	<15%	3.35E+04	5.03E+03	0.15	3.52E-16	2.12E+08	4.74E-09
50	410-430		~1.4E+12	2.00E-02	<12%	6.54E+04	7.85E+03	0.12	6.87E-16	4.13E+08	2.14E-09
60	425-450		~8.5E+11	2.00E-02	<12%	1.13E+05	1.13E+04	0.1	1.19E-15	7.14E+08	1.41E-09
80	440-480		~3.5E+11	2.00E-02	<12%	2.68E+05	2.01E+04	0.075	2.81E-15	1.69E+09	5.90E-10
100	480-520		~1.8E+11	2.00E-02	<10%	5.24E+05	3.14E+04	0.06	5.49E-15	3.31E+09	2.99E-10

Covalent Conjugation to Cytodiagnostics Carboxylated Silver Nanoparticles

Our Carboxyl Silver Nanoparticles rely on EDC/NHS chemistry for conjugation. EDC and NHS “activate” the carboxyl groups on the particle surface to form an intermediate that can subsequently react with primary amine groups on the specific protein or other ligand to be conjugated.

The following protocol provides general guidelines for coupling biomolecules to our Carboxyl Silver Nanoparticles, with conjugation of a standard IgG to our 20nm Carboxyl Silver Nanoparticles given as an example. For conjugation of other biomolecules, the optimal conjugation conditions may vary. To obtain maximum conjugation to the particle surface, the amount of protein for conjugation is about 1 to 10X excess that of its theoretical quantity needed for full coverage

Materials and Equipment Required

- Carboxyl Silver Nanoparticles
- Negative control: Methyl Silver Nanoparticles
- 1-Ethyl-3-[3-dimethylaminopropyl]carbodiimide hydrochloride (EDC) (Sigma, Cat# E1769)
- N-hydroxysulfosuccinimide (Sulfo-NHS) (Sigma, Cat# 56485)

- Blocker: Bovine Serum Albumin (BSA) (Sigma, Cat# A3059)
- Activation buffer: 2-(N-morpholino)ethanesulfonic acid (MES) buffer (10 mM, pH 5.5)
- Coupling buffer: 1X Phosphate Buffered Saline (PBS)
- Washing buffer: 1X Phosphate Buffered Saline + 0.05% Tween 20 (PBST)
- UV-VIS Spectrophotometer
- Protein of interest to be conjugated.

Note: For effective conjugation, the purity of the protein needs to be considered. Any other molecules containing primary amines (e.g. TRIS) may compete with the protein to be conjugated and reduce the conjugation efficiency. The protein should also have enough accessible primary amine groups for conjugation. Lysine residues are the primary target sites for EDC/NHS conjugation. A higher number of lysine groups on the outer surface of the protein will probably lead to higher conjugation efficiency. For example, bovine serum albumin (BSA) has 30 to 35 lysine groups available on its surface for EDC conjugation. An IgG antibody molecule typically has about 90 lysine residues, and 30 are potentially useful for conjugation.

Procedure

1. Prepare fresh EDC/NHS mix solution in 10mM MES buffer (pH 5.5) at a concentration of 30 and 36 mg/mL, respectively.

Note: EDC/NHS rapidly hydrolyzes in aqueous solutions and should be prepared fresh just prior to conjugation.

2. Remove a 10 μ L aliquot of 20 nm carboxyl silver nanoparticles from the stock vial and mix with 10 μ L of EDC/NHS mix solution as prepared in step 1.
3. Incubate for 30 min at room temperature.
4. Add 1 mL of PBST and vortex thoroughly**
5. Spin down by centrifugation at 6,500 g for 30 min
6. Remove most of the supernatant.
7. Add 10 μ L of IgG (1 mg/mL in 1X PBS)***
8. Sonicate in a water bath sonicator for 10 sec.
9. Incubate for 2 to 4 hours at room temperature with mixing.
10. Add 1 mL of PBST and vortex thoroughly.
11. Spin down by centrifugation at 3,500 g for 30 minutes
12. Remove most of the supernatant.
13. Add 50 μ L PBS with 1% BSA
14. Store at 4 degrees and ready to use.

** For smaller proteins, peptides, and amine-modified oligonucleotides or other ligands a one-step conjugation procedure may be employed, i.e. simultaneous activation and conjugation.

*** The concentration of protein may vary depending on the particle size and protein to be conjugated. In general, the amount of protein should be 1X to 10X excess of the amount of full surface coverage. The total surface area of particles and the docking area should be estimated to calculate the optimal amount of protein, see table I.

Carboxyl Silver Particles				Human IgG				
Size	Vol (mL)	Total Surface Area (nm ²)	Number of IgG molecules for full coverage	Docking area of IgG (nm ²)	Conc (mg/mL)	Vol (mL)	Number of IgG molecules	N X full coverage amount
10	1	5.6E+16	1.2E+15	45	3	1	1.20E+16	10
20	1	2.9E+16	6.4E+14	45	1	1	4.00E+15	6.3
30	1	2.0E+16	4.4E+14	45	1	1	4.00E+15	9.1
40	1	1.4E+16	3.2E+14	45	0.5	1	2.00E+15	6.3
50	1	1.1E+16	2.5E+14	45	0.5	1	2.00E+15	8.0
60	1	9.6E+15	2.1E+14	45	0.5	1	2.00E+15	9.5
80	1	7.1E+15	1.6E+14	45	0.5	1	2.00E+15	12.5
100	1	5.6E+15	1.3E+14	45	0.5	1	2.00E+15	15.4

Table 1. Suggested quantities of IgG needed for conjugation to Carboxyl Silver Nanoparticles of different sizes. The docking area of IgG is estimated to be 45 nm², with a molecular weight of 150 kDa. "N X full coverage amount" means the excess ratio between the incubation amount and the amount needed for full coverage of particle surface.

Purification of Nanoparticle Conjugates Using CytoColumn™

1. **IMPORTANT:** If your product or any downstream applications are sensitive to glycerine, make sure to rinse the filtration device with ddH₂O or buffer before use. Trace amounts of glycerine are present in the filtration membrane to prevent drying out.
2. Transfer your conjugated sample into the appropriate CytoColumn™ (see Page 6).

Note I. Ensure that the molecular weight cut-off (MWCO) of the CytoColumn™ is suitable for the components being filtered out (i.e., the reactants being removed should have a lower molecular weight than the cut-off of the column). The recommended MWCO is 100 kDa for nanoparticle products.

Note II. Do not overfill the CytoColumn™, such that there is still some space left. This will mitigate any leakage between the two column components during centrifugation.

3. Using a suitable centrifuge, centrifuge the columns according to the table below, making sure to always use a counterbalance. If there is more volume than the filter device can hold, the remainder of the sample or any wash solutions can be poured into the

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unit on top of the purified product and centrifuged again. Make sure to always empty contents collected at the bottom of the tube between each centrifugation.

Table 1. Recommended centrifugation speeds and times for different volume CytoColumn™.

Column Size	Centrifugation Speed (x g)	Centrifugation Time
0.5 mL	10,000	10 min.
4 mL	1,700	10 min.
15 mL	1,700	10 min.

Note. Centrifugation times will vary based on the MWCO, with smaller MWCO devices requiring longer centrifugation. If the remaining volume of purified product is more than desired, subsequent centrifugations can be done.

- Following centrifugation, carefully collect the purified product using a micropipette. A small volume of collection buffer can be used to rinse and collect any leftover product on the membrane.

Note: The CytoColumn™ can be re-used but ensure that the membrane does not dry out between uses. In the event of drying out, the CytoColumn™ is no longer useable.

- The purified product is now ready for analysis and any subsequent downstream applications.

Validation of Conjugation – Immuno Dot-Blot Assay

We recommend using a straightforward immuno-dot blot protocol to confirm successful conjugation of your antibody. A recommended procedure is described below.

Materials Required

- Antigen or Antibody (1 mg/ml in 1X PBS)
- Antibody or Antigen Silver Conjugate
- Blocking Solution – 5% (w/v) Dry Milk in 1X PBS
- Silver Conjugate Dilution Buffer – 1% (w/v) Dry Milk in 1X PBS
- Wash Solution – 0.05% (w/v) Tween 20 in H₂O
- Nitrocellulose Membrane (Whatman, Cat# 10 402 594C)
- Optional: Mini Incubation Trays (Bio-Rad, Cat#170-3902)
- Optional: Silver Enhancer Kit for Membranes (Cytodiagnosics Cat# SR-01-02)

Procedure

- Prepare a serial dilution of your antigen or antibody in 1X PBS: 0.01, 0.05, and 0.1 µg/µL.
- Spot 1 µL of the above solutions onto a nitrocellulose membrane strip and let air-dry for at least 30 minutes.
- Transfer the membrane strips to a Mini Incubation Tray or a regular glass/plastic 2-mL vial.
- Add 1.5 mL of blocking solution (make sure the solution covers the entire membrane).
- Put the tray or vials on a rocking plate and incubate for 30 minutes at room temperature.
- Dilute your antibody or antigen silver conjugate to a final optical density of 0.2-0.5 with 1% (w/v) dry milk in 1X PBS.
- Remove blocking solution from the tray or vial with the membrane.
- Add 1.5 mL of silver conjugate prepared as in step 6 to the tray or vial.
- Incubate for 2 hours at room temperature. For increased sensitivity, incubation can be performed over night.
- Remove the silver conjugate solution.
- Add 1 mL of water containing 0.05% Tween 20 to wash the membrane.
- Remove the water and repeat washing step twice.
- Add 1 mL of silver enhancing reagents (prepare freshly before use according to instructions in kit).
- Develop for 15 minutes and observe color change.

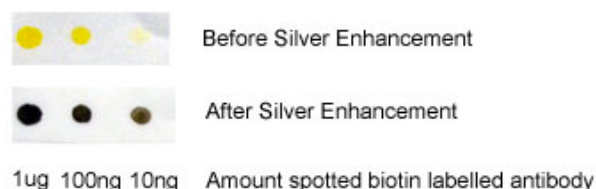


Figure 1. Detection of a biotinylated antibody spotted on a nitrocellulose membrane using streptavidin conjugated silver nanoparticles.

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Frequently Asked Questions

Q: *what is the optimal conjugation pH for conjugation?*

A: The EDC/NHS prefers an acidic environment for higher conjugation efficiency. However, conjugation can occur at pH between 4.5 to 7.4. In our protocol, we activate the carboxyl groups at pH 5.5 first to maximize the carboxyl activation. The excess EDC/NHS is then washed away to prevent protein crosslinking. At this step, the protein to be conjugated can be in buffers of pH from 4.5 to 7.4, depending on the protein.

Q: *what is the optional conjugation time?*

A: 2 to 4 hours at room temperature is generally optimal for proteins. Based on the stability of the protein to be tested, a shorter or longer conjugation time should be tested. The conjugation efficiency of EDC is usually low, so a conjugation time of at least 2-hour is common. We recommend testing different incubation times to find the most optimal.

Q: *what other factors can influence conjugation results?*

A: If the conjugation pH and conjugation time are within the optimal range, but there is no conjugation, it is necessary to make sure EDC/NHS is freshly prepared just before conjugation. EDC should always be stored at -20 degrees. Effective removal of excess EDC/NHS after activation is important to prevent them from crosslinking proteins.

Also ensure that your protein solution is free of any primary amine containing contaminants such as *e.g.* TRIS.

Related Products

- [Conjugation Services](#) – let us solve your problem!

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Catalog Number	Description	Lambda max (nm)	Sizes
SC3K-10- X*	10nm Carboxyl Silver Nanoparticles (3000Da PEG)	390-405	0.5ml, 1.0ml (125 OD)
SC3K-20- X*	20nm Carboxyl Silver Nanoparticles (3000Da PEG)	390-410	0.5ml, 1.0ml (125 OD)
SC3K-30- X*	30nm Carboxyl Silver Nanoparticles (3000Da PEG)	400-410	0.5ml, 1.0ml (125 OD)
SC3K-40- X*	40nm Carboxyl Silver Nanoparticles (3000Da PEG)	405-425	0.5ml, 1.0ml (125 OD)
SC3K-50- X*	50nm Carboxyl Silver Nanoparticles (3000Da PEG)	410-430	0.5ml, 1.0ml (125 OD)
SC3K-60- X*	60nm Carboxyl Silver Nanoparticles (3000Da PEG)	425-450	0.5ml, 1.0ml (100 OD)
SC3K-80- X*	80nm Carboxyl Silver Nanoparticles (3000Da PEG)	440-480	0.5ml, 1.0ml (80 OD)
SC3K-100- X*	100nm Carboxyl Silver Nanoparticles (3000Da PEG)	480-520	0.5ml, 1.0ml (46 OD)
SC5K-10- X*	10nm Carboxyl Silver Nanoparticles (5000Da PEG)	390-405	0.5ml, 1.0ml (125 OD)
SC5K-20- X*	20nm Carboxyl Silver Nanoparticles (5000Da PEG)	390-410	0.5ml, 1.0ml (125 OD)
SC5K-30- X*	30nm Carboxyl Silver Nanoparticles (5000Da PEG)	400-410	0.5ml, 1.0ml (125 OD)
SC5K-40- X*	40nm Carboxyl Silver Nanoparticles (5000Da PEG)	405-425	0.5ml, 1.0ml (125 OD)
SC5K-50- X*	50nm Carboxyl Silver Nanoparticles (5000Da PEG)	410-430	0.5ml, 1.0ml (125 OD)
SC5K-60- X*	60nm Carboxyl Silver Nanoparticles (5000Da PEG)	425-450	0.5ml, 1.0ml (100 OD)
SC5K-80- X*	80nm Carboxyl Silver Nanoparticles (5000Da PEG)	440-480	0.5ml, 1.0ml (80 OD)
SC5K-100- X*	100nm Carboxyl Silver Nanoparticles (5000Da PEG)	480-520	0.5ml, 1.0ml (46 OD)

NOTE: X* is either -25 for 0.5ml format, or -50 for 1.0ml format.

Catalog Number	Description	Sizes
MWC-3-X*-Y*	MWCO Ultrafiltration Spin Columns, 3 kDa	0.5ml, 4ml, 15ml
MWC-10-X*-Y*	MWCO Ultrafiltration Spin Columns, 10 kDa	0.5ml, 4ml, 15ml
MWC-30-X*-Y*	MWCO Ultrafiltration Spin Columns, 30 kDa	0.5ml, 4ml, 15ml
MWC-100-X*-Y*	MWCO Ultrafiltration Spin Columns, 100 kDa	0.5ml, 4ml, 15ml

X* Indicates column volume, 05 for 0.5ml, 4 for 4ml, 15 for 15ml

Y* Indicates number of columns, 1 for 1 column, 5 for 5 columns. i.e. MWC-3-05-1, 3kDa cut-off, 0.5ml column pkg size of 1

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