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Synthesizing Bismuth Nanoparticles

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Introduction

Nanotechnology is becoming a focus in the biomedical field and due to their extensive literature and biocompatibility, gold nanoparticles (AuNPs) have been the most thoroughly investigated with promising results. However, AuNPs have two key limitations: they are non-biodegradable and have been found to have non-acute toxicity due to accumulation in cells, and gold is expensive, making their future wide-spread accessibility limited. Fortunately, an alternative to AuNPs has been gaining attention: bismuth nanoparticles (BiNPs), but with the current lack of methods for BiNP synthesis compared to other metals, it is a major disadvantage for their adaptation.

Objectives

- Method development for size-controlled (20-50 nm) synthesis of BiNPs.
- Synthesize bismuth nanoparticles with various ligands.

Materials

1. Tested varying literature synthesis with different metal to ligand ratios to synthesize BiNPs. These were characterized through DLS (dynamic light scattering), which measures their hydrodynamic diameter and surface potential, using an instrument called a Zetasizer (Malvern Nano ZS).
2. Purified MPA-coated BiNPs through ultracentrifuging and centrifuging through a filter.

Results

Table 1. Synthesis of 3-Mercaptopropionic acid (MPA) and alpha-lipoic acid (ALA)-coated BiNPs.

	AuNP Control	4.5:1 Bi:MPA 120x NaBH ₄	10:1 Bi:MPA 240x NaBH ₄	4.5:1 Bi:ALA 240x NaBH ₄	3:10 Bi:ALA 120x NaBH ₄
Hydro- dynamic Diameter (nm)	13.66 ± 6.76	79.2 ± 42.6	78.2 ± 40.8	112.3 ± 62.22	59.5 ± 29.9
PDI	0.245	0.287	0.272	0.329	0.232

*PDI = polydispersity index

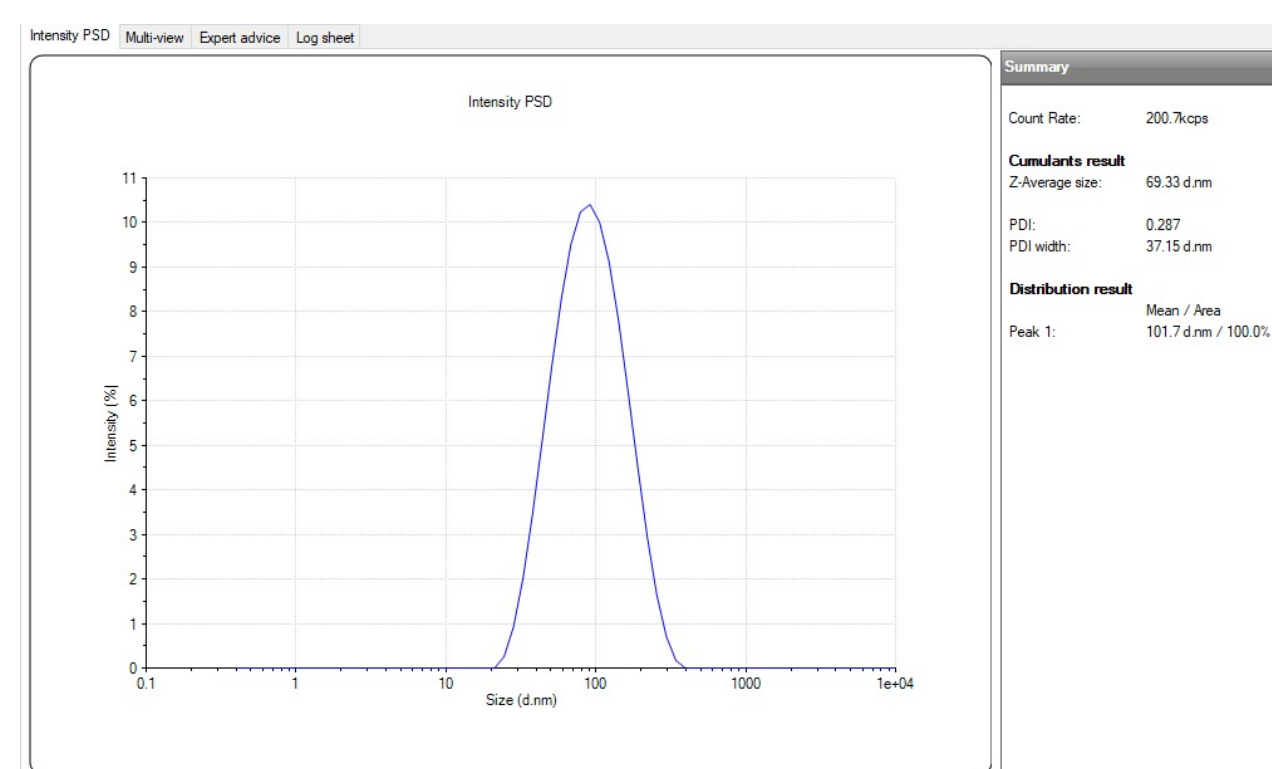


Figure 1. DLS of 4.5:1 Bi:MPA 120x NaBH₄.

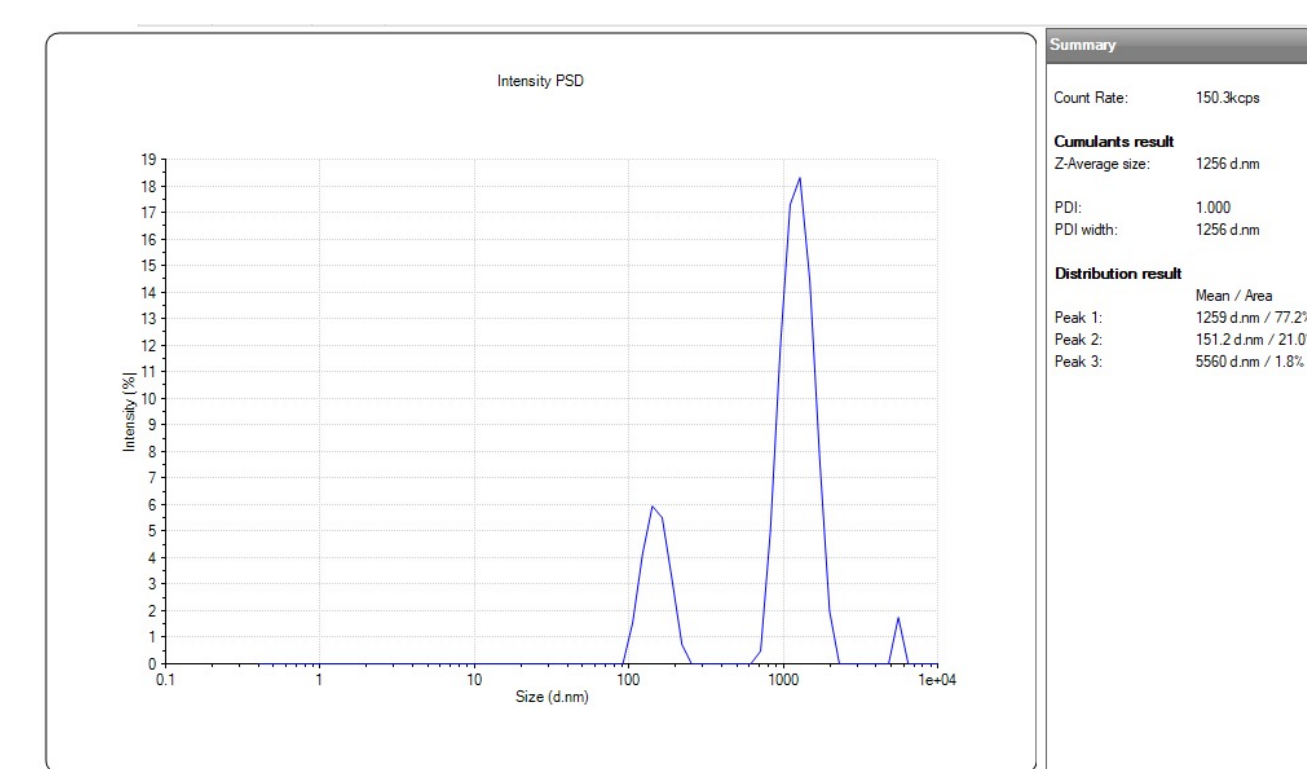


Figure 2. DLS of 4.5:1 Bi:MPA 120x NaBH₄ after ultracentrifuging.

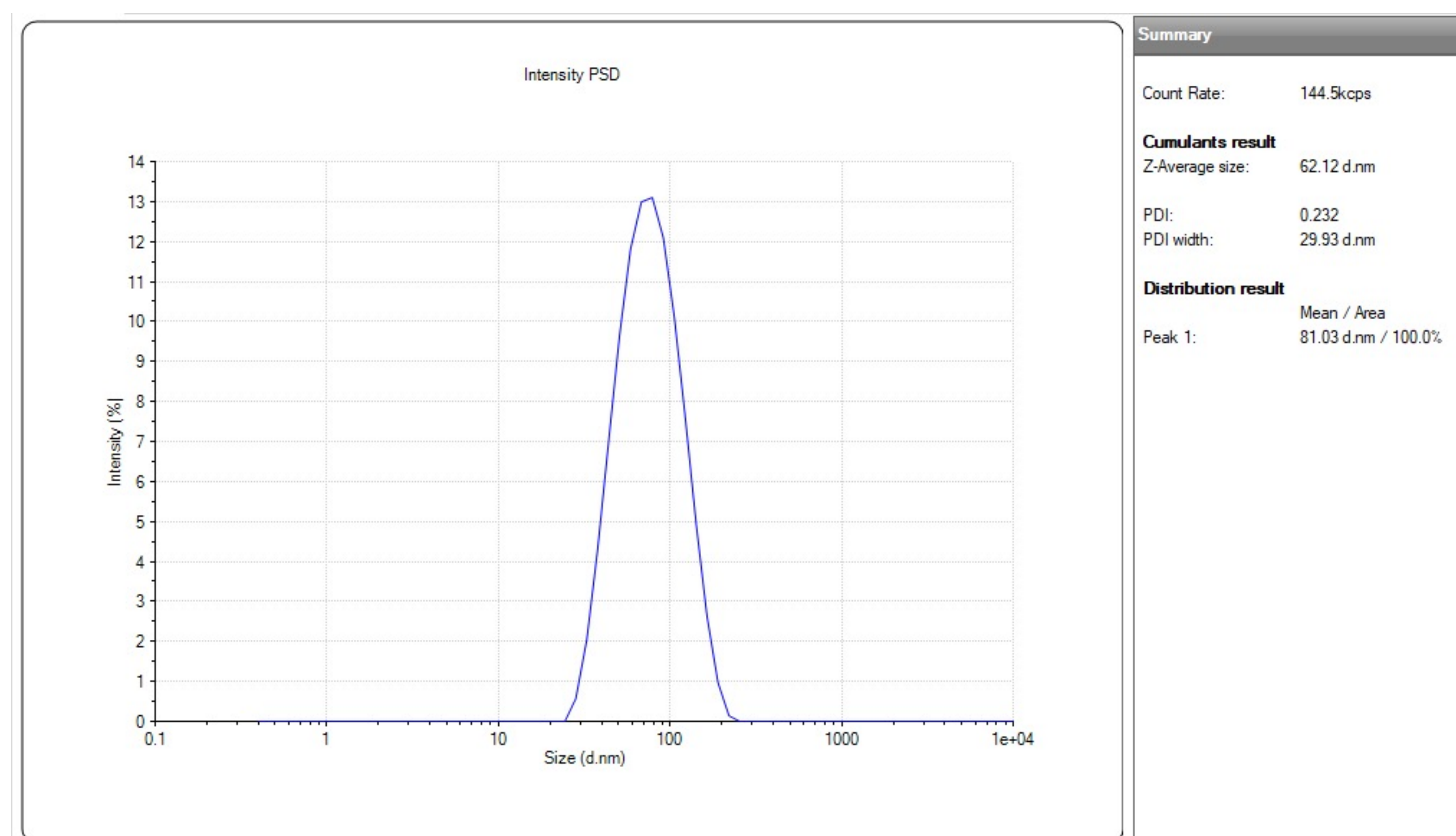


Figure 3. DLS of 3:10 Bi:ALA 60x NaBH₄.

Conclusion

- BiNP synthesis produced the best results using a 4.5:1 MPA:Bi with 60 equivalents of NaBH₄ reducing agent and 3:10 ALA:Bi ratio with 60 equivalents of NaBH₄.
- Purification through ultracentrifuging and centrifuging caused aggregation of the nanoparticles.

Future Direction

- Purify nanoparticles to increase size uniformity.
- Successfully synthesize EG₆ ligand.
- Synthesize BiNPs using EG₆ ligand.

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References

- De Jong, W. H.; Hagens, W. I.; Krystek, P.; Burger, M. C.; Sips, A. J. A. M.; Geertsma, R. E. *Biomaterials* **2008**, *29*, 1912.
- Yang, S.; Li, Z.; Wang, Y.; Fan, X.; Miao, Z.; Hu, X.; Li, Z.; Sun, Y.; Besenbacher, F.; Yu, M. *ACS Appl. Mater. Interfaces* **2018**, *10*, 1605.
- Wang, K.; Zhuang, J.; Liu, Y.; Xu, M.; Zhuang, J.; Chen, Z.; Wei, Y.; Zhang, Y. *Carbohydrate Polymers* **2018**, *184*, 445.
- Yang, C.; Guo, C.; Guo, W.; Zhao, X.; Liu, S.; Han, X. *ACS Appl. Nano Mater.* **2018**, *1*, 820.
- Bi, H.; Dong, Y.; Yang, D.; Dai, Y.; Xu, L.; Lv, R.; Gai, S.; Yang, P.; Lin, J. *Chem. Mater.* **2018**, *30*, 3301.
- Brown, A. L.; Goforth, A. M. *Chem. Mater.* **2012**, *24*, 1599.
- Serfontein, W. J.; Mekel, R. *Res. Commun. Mol. Pathol. Pharmacol.* **1979**, *26*, 391.
- Briand, G. G.; Burford, N. *Chem. Rev.* **1999**, *99*, 2601.