

Report – 5

We have seen that, there is an unknown explicit factor which directs and favors the formation of nanorods over nanosheets and vice versa. Though this explicit factor is not yet to be found, there is a plausible hypothesis that surfactants play a key role in these different dimensional products. Apart from nanorods and nanosheets, there are also unwanted products in the product solution like nanospheres whose formation are not yet predictable.

We study gold nanorods to understand or hypothesize the necessities and requirements for the formation of nanorods. For gold nanorods, Cetyltrimethylammonium bromide (CTAB) are extensively used in excess quantity to obtain nanorods in huge amounts. Compared to CTAB, Gemini surfactants tends to disperse gold more and thus produce more nanorods. But unfortunately, we still could not figure out the actual chemistry behind Gemini surfactants.

In an attempt to understand the role of CTAB in the gold nanorods formation, extensive experiments were held, by varying parameters like varying pH, CTAB concentration, gold solution or seed concentration, temperature of the solution and many more. Lastly the type of CTAB, i.e., the manufacturing company of CTAB is varied. Though theoretically, we expect the result to be same, there was huge deviation in the production of gold nanorods.

The only parameter which was different in, various CTAB manufacturing companies was that of the amount of impurities associated with it. Fortunately, the impurity concentration seemed to play a huge role in the formation of more gold nanorods and unfortunately the impact of concentration of impurities does not follow a trend. Many cases which were considered include 99%, 98%, 95%, 90% purity CTAB of various manufacturing company. Results showed variation in patterns. In accounting the above results, external impurities were added like Sodium Bromide, Potassium Bromide, Benzenedimethylammonium chloride (BDAC), Cetyltrimethylammonium chloride (CTAC) in very small amounts in hope of increasing the production of nanorods. But unfortunately, these added impurities did not even induce the production of gold nanorods.

For the formation of nanorods two stages plays prominent role in the rate determining step and those include seed formation stage and nanorod formation stage. It becomes necessary for analyzing at what step/stage CTAB plays a crucial role. Through experiments, it became clear that CTAB is necessary and important in both these stages and thus is part of the rate determining step.

Through these facts we can conclude that CTAB, which is primarily used as the surfactant for nanorod formation (especially gold) has major part in the seed formation and nanorods formation. We can also see that CTAB manufacturing company and the associated impurities with CTAB also plays a crucial role in the formation of nanorods. Thus, it becomes necessary in our experiment to consider CTAB from various manufacturing companies with varying impurities to obtain TiB_2 nanorods.

References:

1. Smith, Danielle & Korgel, Brian. (2008). The Importance of the CTAB Surfactant on the Colloidal Seed-Mediated Synthesis of Gold Nanorods. *Langmuir : the ACS journal of surfaces and colloids*. 24. 644-9. 10.1021/la703625a.
2. Burrows, Nathan & Lin, Wayne & Hinman, Joshua & Dennison, Jordan & Vartanian, Ariane & Abadeer, Nardine & Grzincic, Elissa & Jacob, Lisa & Li, Ji & Murphy, Catherine. (2016). The Surface Chemistry of Gold Nanorods. *Langmuir*. 32. 10.1021/acs.langmuir.6b02706.
3. Gómez-Graña, Sergio & Hubert, Fabien & Testard, Fabienne & Guerrero-Martínez, Andrés & Grillo, Isabelle & Liz-Marzán, Luis & Spalla, Olivier. (2011). Surfactant (Bi)Layers on Gold Nanorods. *Langmuir : the ACS journal of surfaces and colloids*. 28. 1453-9. 10.1021/la203451p.