Report – 4

We have seen that to form nanomaterial, role of surfactant is very crucial. The concentration, geometry, micelle formation strength and viscosity play a key role in the geometry, dimensionality and concentration of nanomaterial formed. But a question arises as to what forces the formation of nanorods (a 1-D nanomaterial) and nanosheets (a 2-D nanomaterial).

For nanosheets formed in the solution, the surfactant's concentration plays a key role in determining the dimension of nanosheets. Here the dimension refers to the thickness of the nanosheets. According to the research, the thickness decreases with increase in the surfactant concentration. So, we get thinner nanosheets. Also, for stable dispersion in the solution, little surfactant concertation is required. It has also been stated that all the surfactants (well known surfactants), react or behave in similar manner, in the case of nanosheet exfoliation. Thus, we can say that surfactant choice is less important, than it may appear so.

Nanorods formations are associated with formation of micelles. Here, the micelle formation is driven by stronger hydrophobicity and headgroup bulkiness. Nanorods, thus formed is due to adsorption of surfactant in a particular plane unlike nanosheets. We can say that hydrophobicity of surfactants plays a key role in the formation of nanorods. To further enhance this, mixed surfactants (cation and anion) is introduced. This results in less thickness nanorods and are small in nature. Even here, less concentration of surfactants results in less thick nanorods and high concentration of surfactants results in thicker nanorods.

The above two paras give insight regarding how nanosheets and nanorods are formed and also gives insight regarding how concentration of surfactants affect the thickness of the nanomaterial. But we still could not understand, for a particular substrate what forces it to form nanorods and what forces it to form nanosheets.

Now, lets consider the case of zinc oxide (ZnO). Without using any caping agent or surfactants, we intend to form nanomaterial. For an aqueous solution of ZnO, where nanoparticles are formed through some method, the nanoparticle tends to transform into nanosheets and nanorods, by increasing the precursor concentration. Here we know that the solution contains only Zinc ion and hydroxide ions. So, we can hypothesize that the nanorods and nanosheets are formed based on the molar ratio of these ions.

To conclude, it is still not clear, what brings the transition from nanosheets to nanorods or vice versa, especially for the cases where surfactants are involved. From the report we see that increasing and decreasing concentration only affected the dimension and thickness of the nanomaterial (nanosheets and nanorods), but did not give insight regrading the transition from nanosheets to nanorods and vice versa.

References:

1. Griffin, Aideen & Nisi, Katharina & Pepper, Joshua & Harvey, Andrew & Szydłowska, Beata & Coleman, Jonathan & Backes, Claudia. (2020). The Effect of Surfactant Choice and Concentration on the Dimensions and Yield of Liquid Phase Exfoliated Nanosheets. Chemistry of Materials. XXXX. 10.1021/acs.chemmater.9b04684.

2. Bakshi, Mandeep. (2015). How Surfactants Control Crystal Growth of Nanomaterials. Crystal Growth & Design. 16. 10.1021/acs.cgd.5b01465.

3. Morsy, S.M.I.. (2014). Role of surfactants in nanotechnology and their applications. Int J Curr Microbiol Appl Sci.. 3. 237-260.

4. Ganesh, R. Sankar & Mani, Dr. Ganesh Kumar & Elayaraja, R & Durgadevi, Elamaran & M, Navaneethan & Ponnusamy, S. & Tsuchiya, Kazuyoshi & Muthamizhchelvan, C & Hayakawa, Y.. (2018). Surfactant free controllable synthesis of 2D – 1D ZnO hierarchical nanostructure and its gas sensing properties. Applied Surface Science. 10.1016/j.apsusc.2018.02.213.

5. Griffin, Aideen & Nisi, Katharina & Pepper, Joshua & Harvey, Andrew & Szydłowska, Beata & Coleman, Jonathan & Backes, Claudia. (2020). The Effect of Surfactant Choice and Concentration on the Dimensions and Yield of Liquid Phase Exfoliated Nanosheets. Chemistry of Materials. XXXX. 10.1021/acs.chemmater.9b04684.