Surface Modification of Gold Nanorods and Cellular Uptake and Cytotoxicity Studies

Navkhtsetseg Nergui\textsuperscript{1,2,3}, Shobhit Charan\textsuperscript{1,2,3}, Shih-Hsin Huang\textsuperscript{3}, and Peilin Chen\textsuperscript{3}\textsuperscript{*}

\textsuperscript{1}Dept. of Chemistry, National Taiwan University, Taipei 106, Taiwan
\textsuperscript{2}Taiwan International Graduate Program, Nanoscience and Technology Program, Academia Sinica Nankang, Taipei 115, Taiwan
\textsuperscript{3}Research Center for Applied Sciences, Academia Sinica, Nankang, Taipei 115, Taiwan.

Abstract

Nanomaterials have been tempted significant application in the bio-chemistry and material science ever since its creation as a convincing fundamental and applied science tool. While beneficial prospects of the nanomaterials in the bioapplications are well accepted, several reports have presented the negative impact of the nanomaterials on living cells. Distinct design of surface properties accomplished on particle size of the nanomaterials, surface chemistry is liable for their toxic potential. Favorable nanomaterials such as gold nanorod have chosen as a model material in this part of study. The gold nanorod has appropriate Plasmon peaks owning its shape distribution. The chemical procedure was developed to synthesize cetyltrimethylammonium bromide (CTAB) capped gold nanorods. However, the presence of cetyltrimethylammonium bromide (CTAB), which is cationic detergent, is not suitable to be used for biological application due to its cytotoxic nature. In order to replace the CTAB capping over gold nanorods, various different surface modification protocols were employed to reduce the cytotoxicity of GNR’s. Furthermore, cellular uptake and viability studies were performed on HeLa cells to check the biocompatibility and cytotoxicity of various surface modified GNR’s. These gold nanorods were characterized by UV-visible spectroscopy, zeta potential measurements and Transmission electron microscopy (TEM).

Objects

- Study to develop nanomaterial which is highly photo stable for bioimaging applications
- Additionally, surface engineering of these nanomaterial for biomedical applications

requirements for biological applications

\begin{itemize}
  \item Water soluble
  \item Non toxic
  \item Biodegradable
  \item Biocompat
\end{itemize}

Material study

1. Synthesis of Seed

\[
\text{HAuCl}_4 + \text{C}_6\text{H}_5\text{Na}_3\text{O}_7 + \text{NaBH}_4 = (2-4\text{nm}) \quad \text{(2-4nm)}
\]

In a shorter form: \( \text{AuCl}_4^- + 2e^- \rightarrow \text{Au}^0 + 4\text{Cl}^- \)

2. Preparation of the growth solution

\[
\text{HAuCl}_4 + [(\text{C}_{16}\text{H}_{33})\text{N(CH}_3\text{)}_3\text{Br + C}_6\text{H}_8\text{O}_6 \rightarrow \text{Au}^3 \text{ to Au}^+ \text{ (colorless solution)}
\]

\[
m\text{AuCl}_4^- + n\text{C}_{19}\text{H}_{42}\text{BrN} + 2e^- \rightarrow m\{(\text{C}_{19}\text{H}_2\text{N})^+\text{AuCl}_2^-\} + 2\text{Cl}^-
\]

Cellular Uptake Studies

Figure showing the absorption spectra of surface modified NIR gold nanorods before & after modification with Polyelectrolytes

Figure showing the absorption spectra of surface modified NIR gold nanorods before & after modification by Pegylation

Conclusion

The surface modified nanorods showed high stability in various coating, as confirmed by Zeta potential analysis. These structural and optical properties of gold nanorods suggest their use for several biomedical applications. mPEG-R modifications provide information that pegulation prevents aggregation of gold nanorods and increase they solubility. The polyelectrolytes coating detoxificate and stabilized CTAB-capped gold nanorods.