L.8: Cancer cell death and bacteria inactivation by gold nanorod mediated photothermal effect

Gold nanorods (GNRs), because of their high absorption cross section in the near infrared frequencies have received considerable attention for the photothermal treatment (PTT) of cancer. GNRs can accumulate selectively in tumors due to enhanced permeation and retention effect. PTT using nanoparticles has also attracted attention in last couple of years as a potential alternative for inactivation of antibiotic resistant bacteria. Generally, GNRs are prepared using Cetyl trimethyl ammonium bromide (CTAB), which disrupts bio-membrane integrity causing cytotoxic effects and thus limiting the use of as prepared GNRs for PTT. To overcome the cytotoxicity of CTAB, the coating of GNRs with various polyelectrolytes has been found useful. Coating GNRs with polyelectrolytes is an effective approach to make them bio-compatible. We at Laser Biomedical Applications Section, have investigated the effect of coating of the GNRs with polystyrene sulfonate (PSS-GNRs) and PSS plus Poly Di-allyl Di-methyl Ammonium Chloride (PDDAC-GNRs) on its photothermal conversion efficiency (PTE), cellular uptake, and subsequently the photothermal induced cytotoxicity in human oral cancer cells (NT8e) and inactivation of antibiotic resistant bacteria.

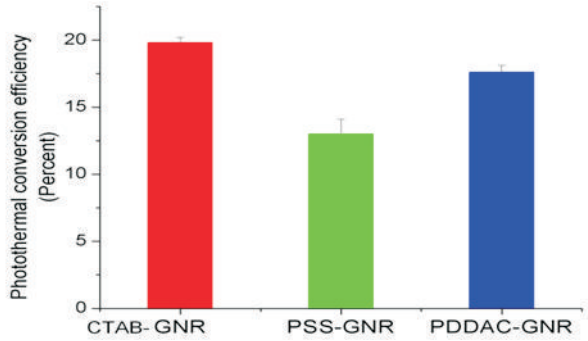

Fig. L.8.1: Photo-thermal conversion efficiency of CTAB-GNR, PSS-GNR and PDDAC-GNR

The results (Fig. L.8.1) show that, the coating of GNRs with PDDAC results in higher PTE as compared to when coated with PSS alone. The intracellular concentration of GNR when coated with PDDAC was ~ 2.5 fold higher than the case when coated with PSS. However, PDDAC-GNRs could not result in better photothermal induced cancer cell damage than that produced by PSS-GNRs (Fig. L.8.2). This is attributed to the intracellular clustering of PDDAC-GNRs, under the influence of acidic pH of the cellular compartment, where the GNRs get localized.

The increasing ubiquity of antibiotic-resistant bacterial strains is one of the problems in medical science for which an acute solution is needed. An effective treatment approach is needed which can be used separately or combined with antibiotics.

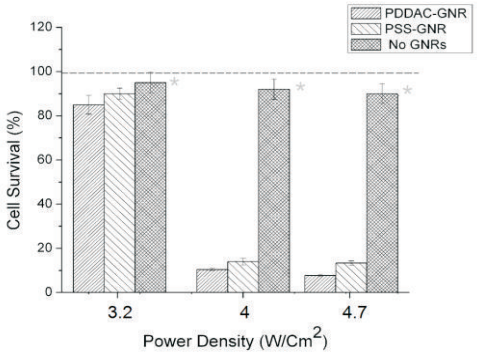

Fig. L.8.2: Percent cell survival of NT8e cells treated with 60 pM of PDDAC-GNR and PSS-GNR for 16 h and irradiated with laser (CW, 780 nm) at 3.2, 4.0 and 4.7 W/cm^2

Nanoparticles based approaches are fast gaining importance in this regard. Silver nanoparticles have been shown to possess anti-bacterial property, but silver ions cause toxicity to the host cells. GNR based photothermal treatment has potential as an alternative approach for anti-bacterial applications.

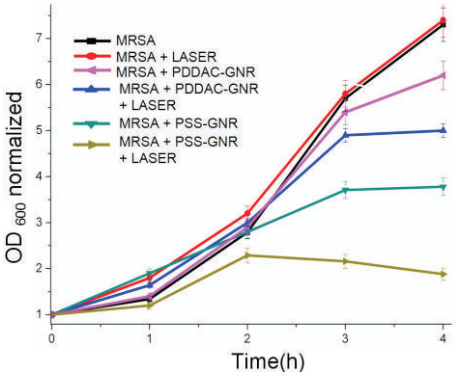

Fig. L.8.3: The growth curve of Methiciliin –resistant Staphylococcus aureus (MRSA) without/with PSS- or PDDAC-GNRs and laser irradiation

At LBAS, RRCAT we have studied the anti-bacterial effect of polyelectrolyte coated GNRs (PSS- and PDDAC-GNRs) on Methicillin-resistant *Staphylococcus aureus* (MRSA) using near infra-red laser. The results (Fig. L.8.3) suggest that there is considerable reduction in growth and viability of bacteria when treated with GNRs and subjected to laser treatment. At similar conditions PSS-GNRs was found to result in maximum inhibition of MRSA growth under laser irradiation as compared to that of the PDDAC-GNRs. The detailed description of the study and its results will be found in *IET Nanobiotechnology* (doi: 10.1049/iet-nbt.2016.0132)

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