

Graphene for improved femtosecond laser based pluripotent stem cell transfection

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Abstract

Pluripotent stem cells are hugely attractive in the tissue engineering research field as they can self-renew and be selectively differentiated into various cell types. For stem cell and tissue engineering research it is important to develop new, biocompatible scaffold materials and graphene has emerged as a promising material in this area as it does not compromise cell proliferation and accelerates specific cell differentiation. Previous studies have shown a non-invasive optical technique for mouse embryonic stem (mES) cell differentiation and transfection using femtosecond (fs) laser pulses. To investigate cellular responses to the influence of graphene and laser irradiation, here we present for the first time a study of mES cell fs laser transfection on graphene coated substrates. First we studied the impact of graphene on Chinese Hamster Ovary (CHO-K1) cell viability and cell cytotoxicity in the absence of laser exposure. These were tested via evaluating the mitochondrial activity through adenosine triphosphates (ATP) luminescence and breakages on the cell plasma membrane assessed using cytosolic lactate dehydrogenase (LDH) screening. Secondly, the effects of fs laser irradiation on cell viability and cytotoxicity at 1064 and 532 nm for cells plated and grown on graphene and pure glass were assessed. Finally, optical transfection of CHO-K1 and mES cells was performed on graphene coated versus plain glass substrates. Our results show graphene stimulated cell viability whilst triggering a mild release of intracellular LDH. We also observed that compared to pure glass substrates; laser irradiation at 1064 nm on graphene plates was less cytotoxic. Finally, in mES cells efficient optical transfection at 1064 (82%) and 532 (25%) nm was obtained due to the presence of a graphene support as compared to pristine glass. Here we hypothesize an up-regulation of cell adhesion promoting peptides or laminin-related receptors of the extracellular matrix (ECM) in cell samples grown and irradiated on graphene substrates. By bringing together advances in optics and nanomaterial sciences we demonstrate pathways for enhancement of pluripotent stem cell biology.