Selective Deactivation of M13 Bacteriophage in E. Coli using Femtosecond Laser Pulses

P. Molukanele [1, 3], A. Du Plessis [1], T. Roberts [1], L. Botha [1], M. Khati [2,3], W. Campos [2, 3]
[1]*CSIR National Laser Centre, Femtosecond Science group, Pretoria, South Africa*
[2]*CSIR Biosciences, Aptamer technology research team, Pretoria, South Africa*
[3]*University of Cape Town, Cape Town, South Africa*
E-mail: pmolukanele@csir.co.za

Abstract: Potential for the selective deactivation of viruses while leaving the sensitive material such as the host cell unharmed was studied using a femtosecond laser system, and preliminary results will be reported.

1. Introduction

Viruses can be described as acellular organisms whose genome consists of nucleic acid that replicate inside living cells (host cells) using the cellular synthetic machinery, and cause the synthesis of specialized elements called virions, that can transfer the genome to other cells. M13 bacteriophage (virus which infects only bacteria) is a filamentous virus that is about 1 µm long and 5-6 nm in diameter. Its host Escherichia coli (E.coli), is approximately 2-6 µm long and 1-1.5 µm in diameter, see figure 1 below.

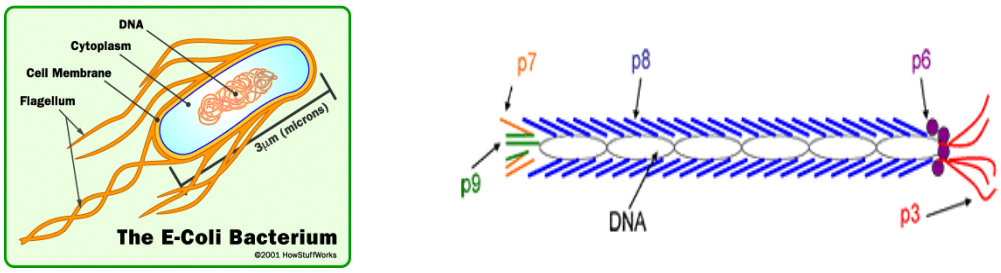

Figure 1: Schematic representations of M13 bacteriophage and its host E.coli.

While some viruses are useful and used in therapy, others can cause disastrous diseases and hence tremendous efforts have been made to eliminate them. Most antiviral and antibacterial treatments are only partially successful and may evoke problems of drug resistance and unwanted side effects.

An effective method of deactivating these viruses while leaving the sensitive material such as the host cell unharmed, have been demonstrated by Tsen et al [1, 2]. In these studies, the weak links on the protein shells of the viral particles were targeted. By tuning to the appropriate laser power density, the feasibility of damaging the protein shells of the viral particles hence leading to inactivation, without harming the host cells was demonstrated. Virus deactivation was monitored by plaque count method.

In this work, we report preliminary experimental results in a proof of principle comparative experiment using the M13 bacteriophage in E. coli host cells. In particular we focus on the deactivation intensity threshold and compare this to the damage threshold for the host cell. We envisage that such a study will ultimately lead to a better understanding of the mechanism of virus deactivation using femtosecond laser pulses, which is currently still not understood. This understanding of the physical phenomenon will be useful for practical application development in a wide variety of possible scenarios, and is not limited to specific viruses or host cells.

2. References

[1] K.T. Tsen, S-W.D. Tsen, C-F. Hung, S. M. Lindsay, K. Kibler, B. Jacobs, T-C Wu, B. Karanam, S. Jagu, R.B.S. Roden, C-Fu Hung, O.F. Sankey, B.Ramakrishna, J.G Kiang, "Photonic approach to the selective inactivation of viruses with a near-infrared subpicosend fiber laser", 2009, Journal of Bio.med Optics 14 (6), 064042.

[2] K.T. Tsen, S-W.D. Tsen, C-L. Chang, C-F. Hung, T.C. Wu, J.G. Kiang, "Inactivation of viruses by coherent excitations with a low power visible femtosecond laser" *Virology Journal* **2007**, *4*, 50.