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Michigan Institute for Plasma Science and Engineering

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Room 1311
EECS Building

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Plasma Medicine: Low Temperature Plasma as a Transformational Technology for the Healthcare Field

Low temperature plasmas produce chemically active species including reactive oxygen species (ROS) such as O, O_2^-, and OH and reactive nitrogen species (RNS) such as NO and NO_2. These species exhibit strong oxidative properties and/or trigger signaling pathways in biological cells. For example oxidation by plasmas of the lipids and proteins that constitute the membrane of biological cells leads to the loss of their functions. In such environments bacterial cells die in minutes or even seconds, depending on the strain. Plasmas have been found to be an effective method to control the proliferation of biofilms. Biofilms are very resistant to chemicals found in detergents and even to antibiotics. Therefore, if not controlled, biofilms (including dental plaque) could represent serious health hazards.

Under some conditions, low temperature plasmas appear to cause little damage to living animal and plant tissues. Having different structures and morphologies, bacterial and mammalian cells exhibit different responses to physical and chemical stresses. For example, skin fibroblast cells remain viable under plasma conditions that can be lethal to bacterial cells. However, plasmas can induce apoptosis, or programmed cell death, opening the possibility to use plasma technology to kill cancerous cells.

The proliferation of fibroblasts is an important step in the wound healing process. The ability of plasmas to kill bacteria and to accelerate the proliferation of specific tissue cells open up the possibility to use plasmas for the healing of chronic wounds such as diabetic ulcers. Tens of thousands of amputations occur every year in the US because of the inability of present medical methods to heal chronic wounds. Plasmas may be an alternative treatment.

The above applications have ushered in a new transformational approach to healthcare referred to as Plasma Medicine. In this presentation background work as well as recent results both in fundamental understanding and applications will be discussed.

About the Speaker: Dr. Mounir Laroussi received his Ph.D. in Electrical Engineering from the University of Tennessee. He is now Professor in the Electrical & Computer Engineering Department of Old Dominion University (ODU) and is the Director of ODU's Laser & Plasma Engineering Institute (LPEI). Dr. Laroussi's research is in the Physical Electronics area and particularly in the physics and applications of non-equilibrium plasmas. He has been working on the biomedical applications of non-thermal plasmas since the mid-1990s when he investigated the germicidal properties of atmospheric pressure plasmas. In the past few years he has been investigating the potential of using plasmas in dental applications, wound healing, and killing of cancer cells. He has more than 100 publications in journals and conference proceedings, and holds several patents. He has served in the Administrative Committee (2002-2005) and the Plasma Science and Applications Executive Committee (2005-2007) of the IEEE Nuclear and Plasma Science Society (NPSS). He has also served as a Guest Editor of the IEEE Transactions on Plasma Science and as the General Chair of the 2010 International Conference on Plasma Science. He now serves on the Editorial Boards of Plasma Processes and Polymers and the International Journal on Plasma Medicine. Dr. Laroussi is a Fellow of IEEE, an IEEE-NPSS Distinguished Lecturer, and is the recipient of the 2012 NPSS Merit Award for his pioneering work on the biomedical applications of low temperature plasmas.