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A Window to the Future

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It’s not everyday that a physicist develops a technology that is innovative, useful, and exciting to fans of the Sci-Fi television hit “Star Trek”. In 1995, Dr. Ady Hershcovitch, a physicist at Brookhaven National Lab, did just that by developing the plasma window, a device that has the ability to separate vacuum from atmosphere using a plasma arc. This novel creation has shown vast potential for uses in electron beam welding and various facets of scientific research.

The plasma window was initially conceived by Dr. Hershcovitch when he viewed an electrical arc and realized the potential of a stream ionized particles to be used as a barrier. He recognized that such an invention would make certain processes, like electron beam welding (EBW), easier and more efficient. Prior to the advent of the plasma window, EBW was limited by the fact that it had low production rates and limits on the size of the material to be welded because it had to be done in a vacuum. When not done in a vacuum, many of the benefits of EBW are lost due to dispersion of the electron beam by air. Dr. Hershcovitch sought out a way to nullify the shortcomings of both ways of processing. He developed a plasma window that would allow the particle beam to be created in a vacuum but used at atmospheric pressure, and through the use of a plasma arc (constantly streaming ionized gases charged by electricity), he was able to create a window that would allow the electron beam to jump from vacuum to atmosphere. (Hershcovitch, 1998) Thus, Dr. Hershcovitch succeeded in creating a device that would both improve EBW and display great promise for future uses in research technologies.

The plasma window is created when inert gas molecules are stripped of their electrons and accelerated across the “window”. To keep the flow of ionized particles confined to a very narrow strip across the window, electrical and magnetic fields are used. The ions are heated to temperatures around 12,000-15,000 Kelvins, giving the resulting plasma a very low density which decreases particle beam diffraction as it passes through. The incredibly high temperature also makes the plasma exceedingly viscous, creating the desired barrier between vacuum and atmosphere. These factors allow the plasma window to be thousands of times more effective at maintaining a vacuum than previously used pumping methods. (Kren, 2004)

One principal use is in the field of electron beam welding, where it has had a significant impact. *Industry Week* (2004) states that by "eliminating the need for welding within a vacuum chamber", the plasma window produces energy savings of 90%. Currently, a company in Connecticut called Acceleron is working with Dr. Hershcovitch to implement the plasma window in commercial uses of EBW. For Acceleron, the plasma window yields vast potential. It broadens the scope for the use of the precise and highly advantageous EBW, which could soon be used in the production of airplanes, ships, and spacecraft. The advent of the plasma window could lead to better built and longer lasting machines, potentially changing the face of welding and heavy industry.

The plasma window has the potential to serve many other uses in various fields of science and engineering. According to Dr. Hershcovitch, the plasma window is being used as a research technology in South Africa, Israel, Washington, D.C., and Brookhaven National Laboratory. At Brookhaven it has been used at the National Synchrotron Light Source in X-Ray transmission, where it has proved to be effective as a way to isolate the machine beam line vacuum from the adverse conditions at the various radiation experiments. Its efficiency and effectiveness in X-Ray research and its ability to facilitate a wider range of research (it is effective at higher temperatures than the currently used beryllium window) could help to further the work done in the vital field of high intensity x-ray studies. It has also been proposed to implement a plasma window in the Spallation Neutron Source at Oak Ridge, Tennessee, where it would decrease costs and improve the research by allowing the most intense pulsed neutron beams on earth to pass through barriers unscathed. (Herscovitch and Raparia, 3)

In addition to the current real world applications of the plasma window that currently benefit humans, there are many potential uses for it in aeronautics. According to an article from the AIAA, the use of discharging weak plasmas could play “consistent roles … in… hypersonic drag reduction.” By weakly ionizing the atmosphere through which a hypersonic plane would fly, a plasma window could reduce turbulence and drag, potentially revolutionizing high speed aeronautics. If this occurs, it will be plausible to travel at hypersonic speeds (Mach 5+) through the atmosphere, making our ‘small world’ a great deal smaller.

Most important of all, the plasma window has gained the adoration of Trekkies, who have likened it to the force field in the shuttle bay that keeps the atmosphere of the Starship Enterprise from escaping to space. Unfortunately for them, the energy requirements for a plasma window this large are far too great for this to be practical. That does not deter Dr. Hershcovitch from continuing his first-rate work, which is to be displayed this summer on a History Channel feature on Star Trek technology. Whether the Plasma Window will revolutionize industry, aeronautics, or high energy physics has yet to be seen, but who knows what will come of it? This author looks forward to the day that the Plasma Window will help the human race to explore another “final frontier”.

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