Why Plasma Chemistry is so often a key to breakthrough innovations: from energy systems, electronics, and new materials to water treatment, agriculture and medicine?

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Plasma is a unique engineering tool not only successfully competing with other tools (like in the case of fluorescent vs incandescent light bulbs, or plasma display panels vs kinescopes), but often permitting solutions unthinkable for any alternative engineering approaches (like in the case of melting super temperature-resistant materials, high-aspect-ratio deep reactive ion etching, or even thermonuclear fusion).

Which physics and chemistry make plasma methods and technologies so unique? For thermal plasmas it is extremely high temperatures and energy fluxes above the reach of any alternative approaches. For non-thermal plasmas, it is vice versa ability to generate very energetic species (electron, ions, atoms, radicals, radiation etc) at very low gas/liquid temperatures, which further can be applied, for example, to treat/process very different and often fragile materials (from wafers in electronics to living human tissue), or to generate light as well as other types of radiation.

Significant advantage of plasma approaches is related to their multi-parameter controllability, and electricity/electronic based flexible logistics. Great challenges are often related to plasma processing selectivity and electric energy cost, especially for applications in energy systems, fuel conversion, and agriculture.

We hope that electricity, electronics, and artificial intelligence will dominate our future, which will help us with challenges of processing selectivity and electric energy cost. Inevitable “Electric Future” of our civilization as well as exponentially growing involvement of electronics and AI in modern technologies will surely help plasma chemistry to be more “adaptive” and way more competitive.

But today, before the era of “Electric Future”, our plasma chemical research (as well as this presentation) is focused on plasma solutions unthinkable in alternative engineering approaches (like in the past decades, melting super temperature-resistant materials, or high-aspect-ratio deep reactive ion etching). Do we have new “out of the box” ideas of this kind? Surely we do, including those in energetic materials, electronics, food processing, and plasma medicine. Some of these ideas, recently developed in Nyheim Plasma Institute of Drexel University are to be discussed in this presentation.