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Editorial

On the Omnipresence and Potential of Plasma Technology

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Even though plasma is the most common state of aggregation in the known universe, its complex chemistry and physics, as well as its specifics and particular characteristics, are not yet fully understood [1,2]. However, this medium has made possible a wide range of quite different everyday products and applications—and still does and most certainly will do in the future.

Following the pioneer works by Georg Christoph Lichtenberg, Werner von Siemens, Sir William Crookes, Sir Joseph John Thomson, Irving Langmuir, and others, plasma generators have quite rapidly been established as ozone or light sources. Even though conventional plasma-based fluorescent lamps have been available since the 1930s, plasmas still feature a high potential in lightening technology. Here, novel radiation sources with unique properties, such as, for example, extremely short wavelengths [3] for lithography purposes or highest homogeneity [4], well suited for calibration processes [5], were introduced recently. Moreover, the potential of plasmas as functional devices for the generation of short light pulses in modern Q-switched laser sources was reported [6].

Since the 1960s, technical plasmas have been well established in modern manufacturing and especially in coating technology or surface cleaning, functionalisation, activation, and modification. Here, the improvement of adhesion characteristics is one of the most important and advantageous plasma-induced effects. In the last few decades and years, the use of plasmas as an enabling key technology has allowed for the development of novel approaches and methods in quite different fields of applications. For instance, novel plasma-based healthcare solutions were recently established—which is essential progress, especially with respect to the persisting COVID-19 pandemic [7]. The application of plasmas has also become a powerful tool in dermatology [8] or even minimal-invasive endoscopic cancer therapy [9]. Other comparatively novel branches for plasma applications are food technology and agriculture [10].

Furthermore, plasma technology acts as a driving force for the development of completely novel manufacturing methods or cutting-edge techniques. For instance, plasmas have turned out to allow an enhanced synthesis of nanoparticles [11], the generation of nanoassemblies [12], the development of cloaking devices [13], and the design of efficient power units in astronautics [14]. Another quite new approach is the simultaneous combination of plasmas with other tools or phenomena, such as laser irradiation [15,16], in order to induce advantageous synergies and provide hybrid manufacturing techniques with improved accuracy and efficiency.

Apart from such technical applications, constant research has led to a better understanding of the aggregation state plasma and its interaction with other media [17,18]. Such understanding allows plasma-based materials analysis with high accuracy via inductively coupled plasma atomic emission spectroscopy (ICP-AES) [19] or laser-induced breakdown spectroscopy (LIBS) [20,21]. Even though the latter technique is one of the oldest laser applications, it is highly topical, for example, in space research: In August 2012, a LIBS device named ChemCam was put into operation on Mars, revealing the presence of hydrogen. Most recently, in February 2021, a second LIBS apparatus—the SuperCam on board the Perseverance Rover—was successfully sent to Mars [22]. Here, plasma science

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and technology allows the exploration of distant planets—and maybe the discovery of indications or even evidence of extra-terrestrial life one day . . . ?

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