

The background of the slide features a dark, almost black, field with intricate, glowing blue lines that resemble a complex network or a microscopic view of a material. These lines are thin and have a soft, ethereal glow, with some brighter points where they intersect or form loops. The overall effect is one of technological sophistication and innovation.

A Technological Breakthrough

by Prodea Depolluting

A unique technology

The context

Non Thermal Plasma (NTP), especially DBD Plasma (Dielectric Barrier Discharge), use for air treatment is a destructive and non-selective method, efficient on a multitude of pollutions.

It is 100% electric without consumable, and adapts to different flows.

Despite these assets, it is not widespread in industrial installations. The drawbacks noted are the presence of harmful by-products, such as ozone, but also high energy consumption, and sometimes an inefficiency towards certain pollutants.

We shake things up

Prodea Depolluting breaks new ground by optimizing NTP performances, eliminating these known defects, and dramatically increasing performances and eco-efficiency.

How do we shake things up ?

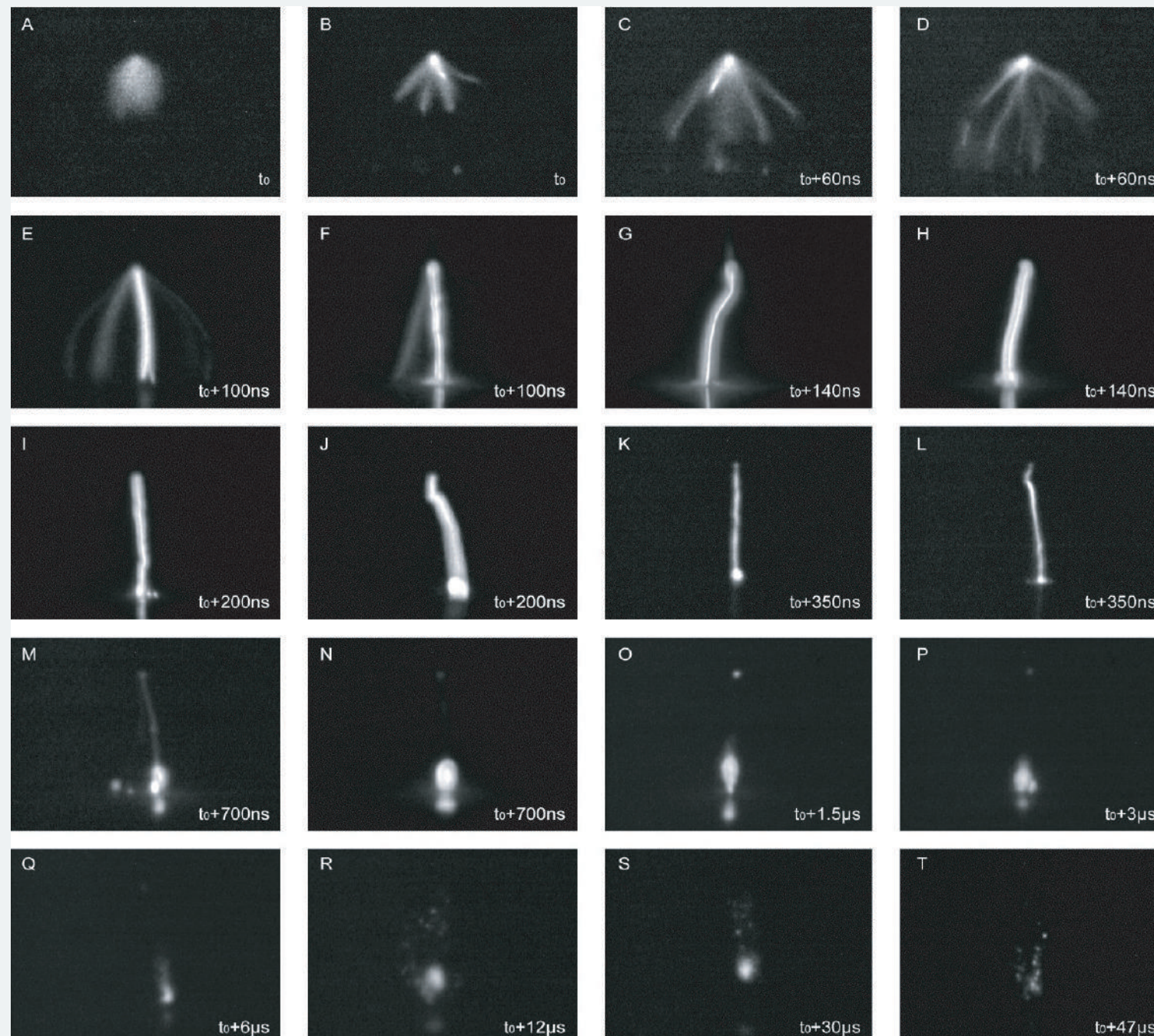
First, by replacing classical used Dielectric Barrier by our exclusive Electroceramic Barrier, and then with a specifically reactor design dedicated to this exclusive electroceramic.

This revolutionary combination achieves incredible feats.

Electrical properties

With our 2-patented material used as barrier, don't say DBD plasma anymore, but EDB plasma for ELECTROCERAMIC BARRIER DISCHARGE PLASMA.

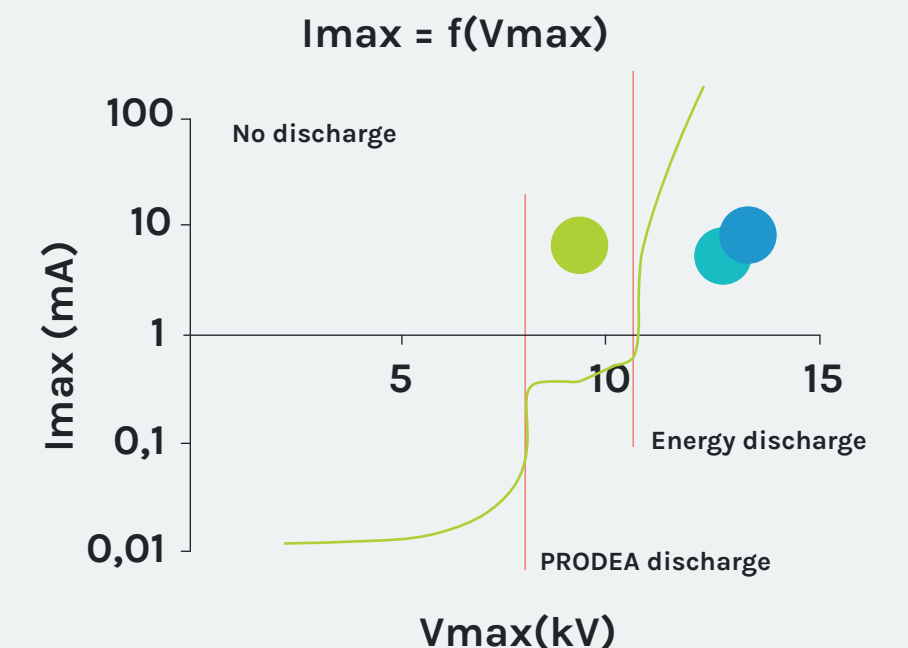
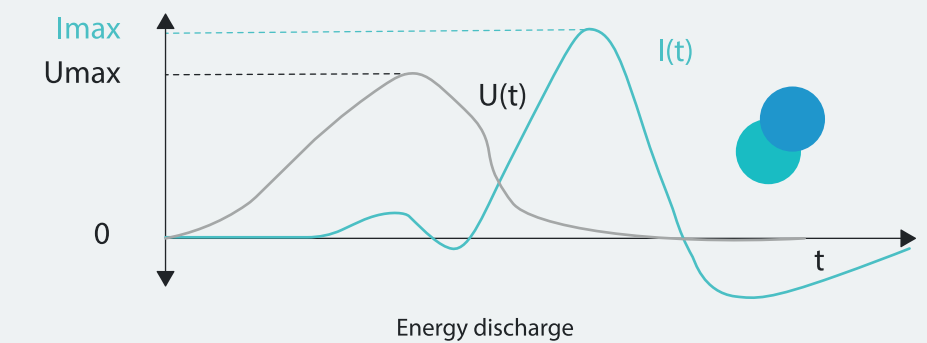
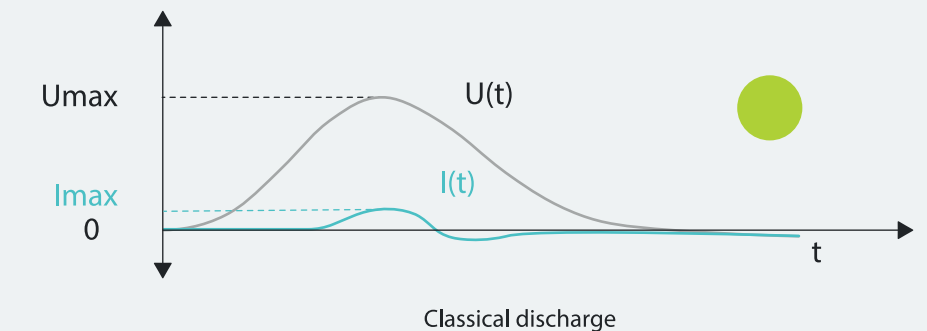
Let's see what happens at this material surface when we apply a voltage signal (HV+ here):



First, we have 400 ns of classical discharge. the energy of these discharges increase with the increasing voltage

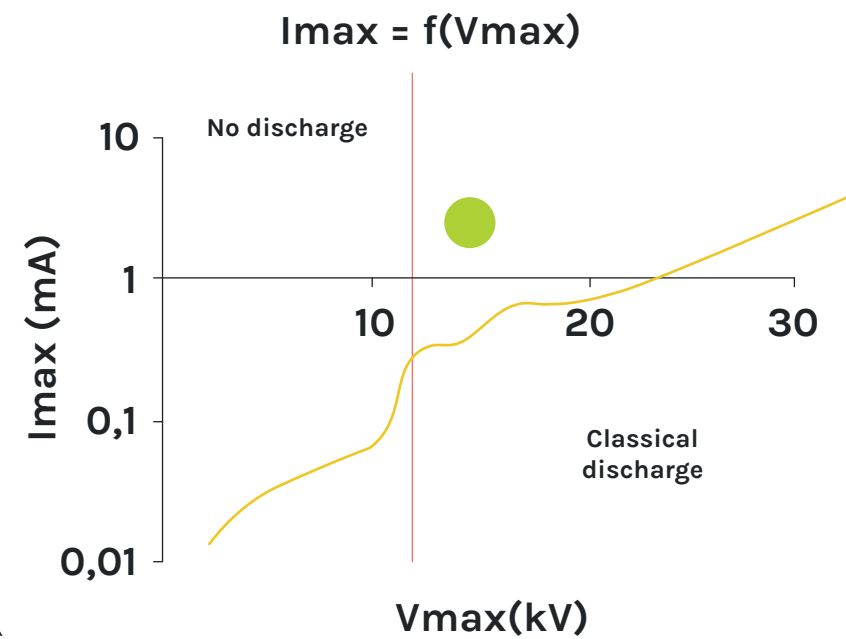
Then, at the max of these classical discharges energy, if we increase again the voltage (50V more), we have an energetic discharge during 700 ns.

When the voltage pulse ends, we see 45 μ s of surfacic residual plasma

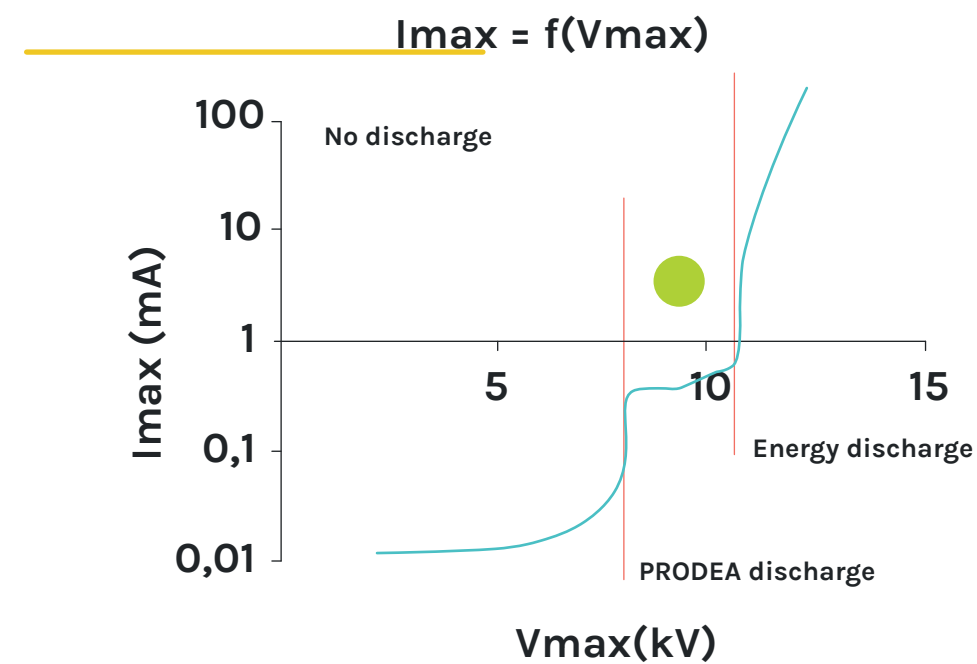


EBD by Prodea versus DBD.

01 Reminder:
With Dielectric (DBD), only classical discharge exists and requires high voltages...unlike EBD,

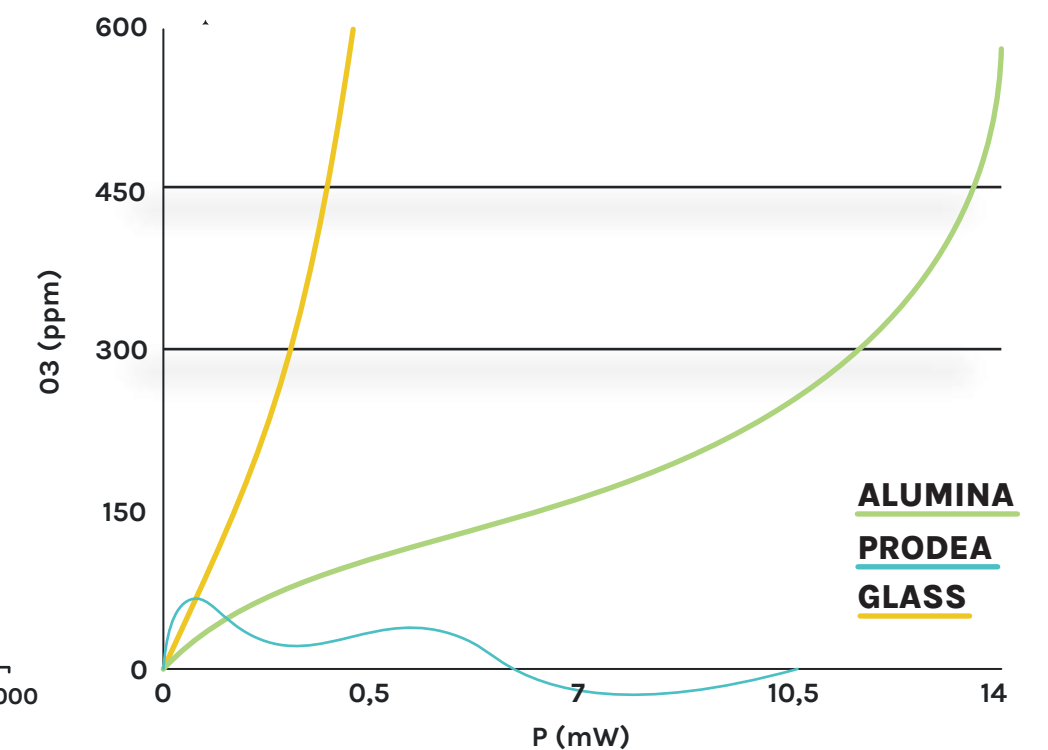
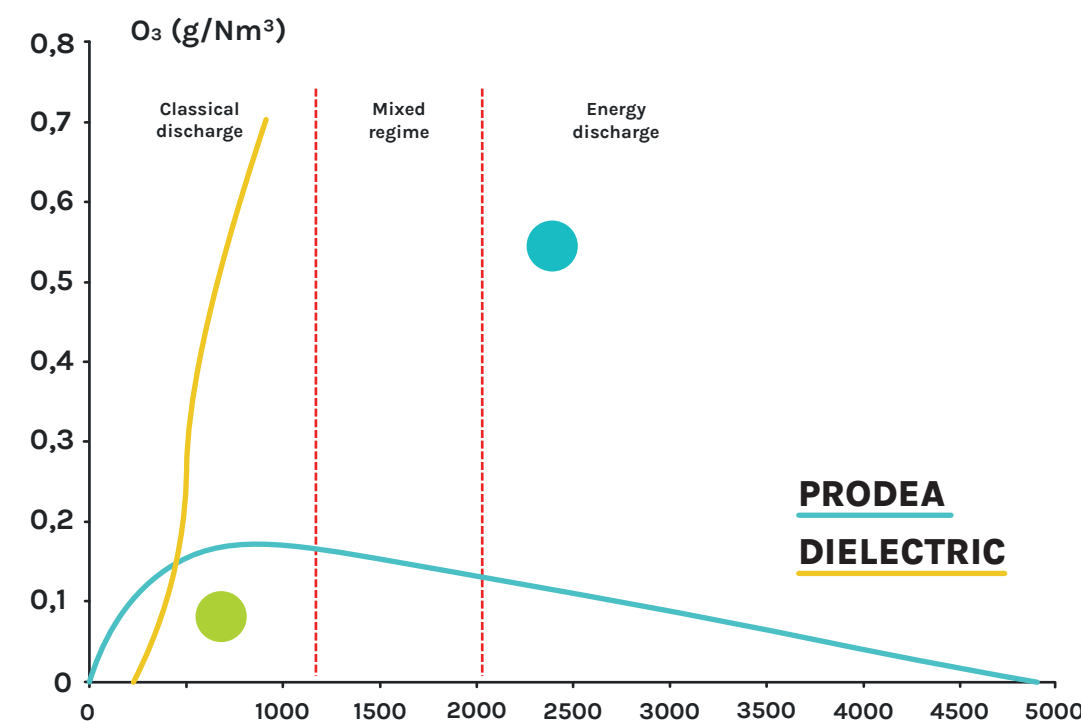


DIELECTRIC BARRIER



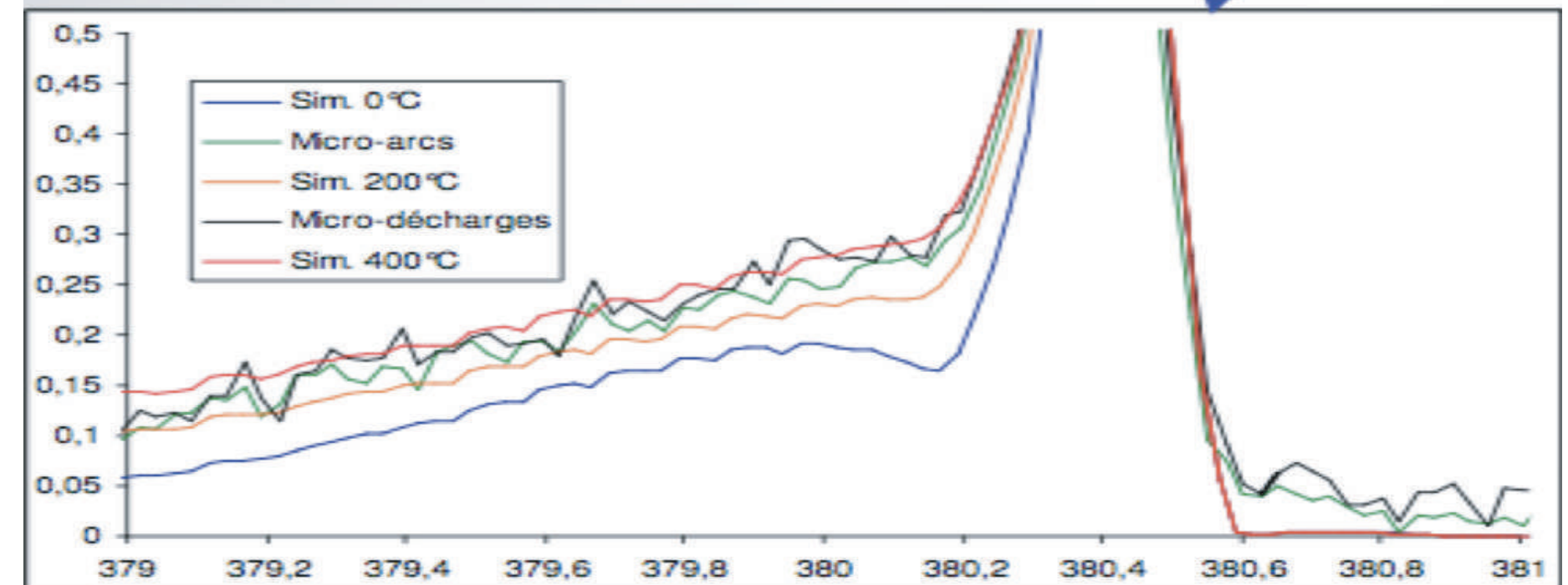
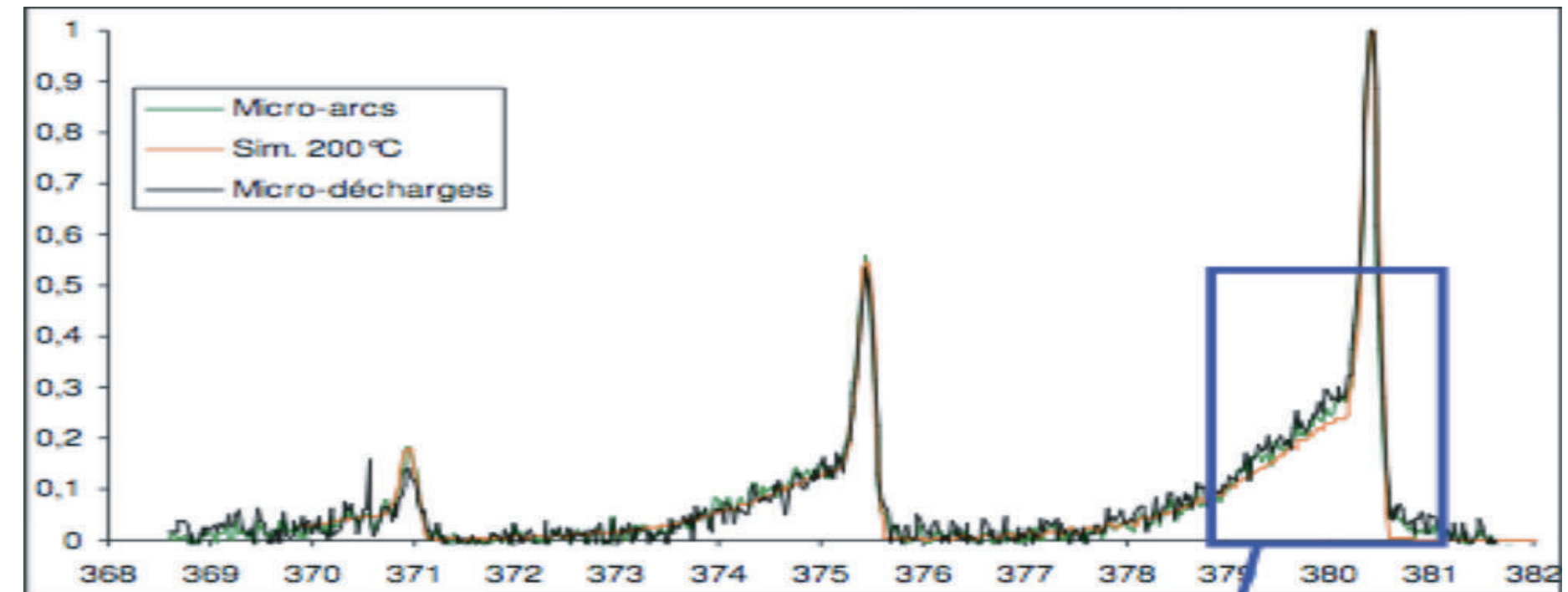
PRODEA BARRIER

02 Ozone production
Thanks to our low levels of voltage and to our high energy discharge regime, no overproduction of ozone occurs.



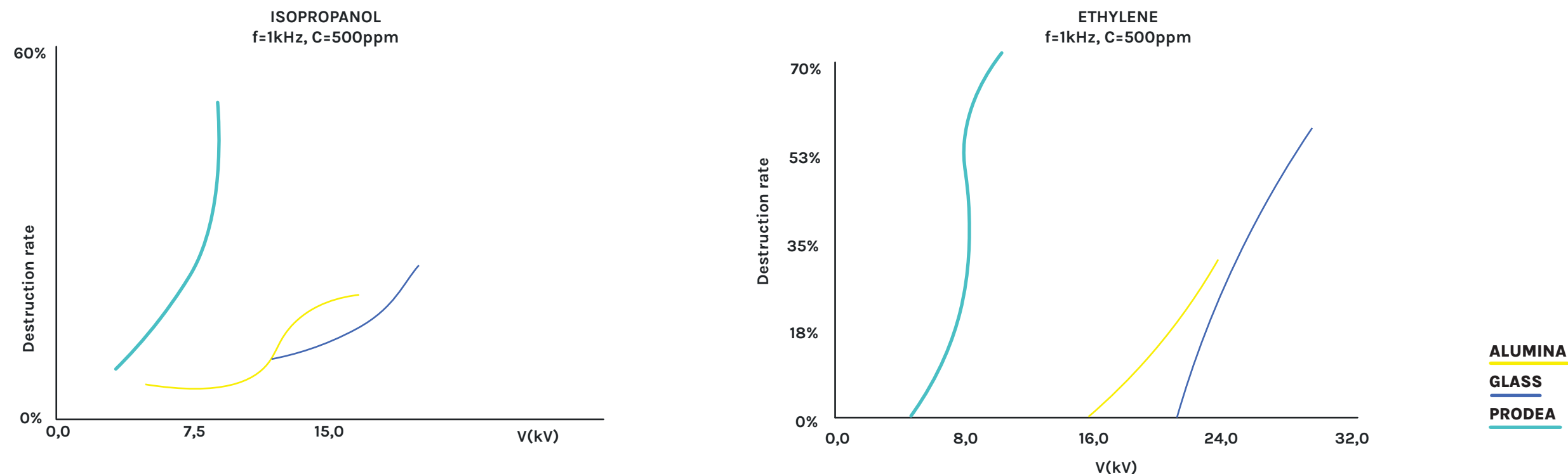
Focus on the energetic discharges

The «energetic» discharges remain cold, it is indeed non-thermal plasma.

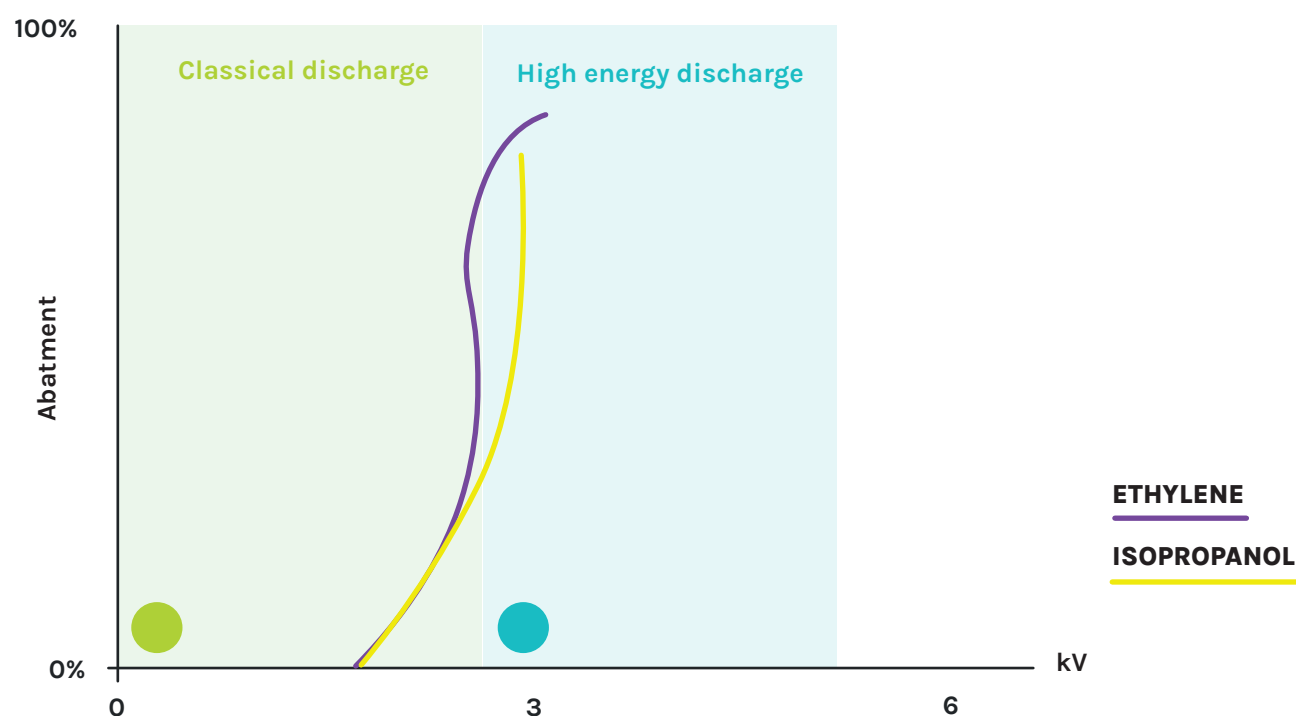


Chemical characterization (HV+)

01 EBD by Prodea versus DBD



02 Effectiveness of the nature of discharge according to targeted pollutants



Abatement occurs at low voltage, in a very short voltage range.

Chemical characterization (AC 50Hz)

To anticipate manufacturability, we chose a maximum operation voltage of 6kV.

With EDB We get 70% abatement for an energy consumption 10 times lower than with DBD. Moreover, in term of compactness, EDB shows extremely interesting performances.

		Concentration	Voltage	Frequency	Abatment rate	Energy
EBD	Butyric acid	25 mg/m3	6 kV	50 KHz	70%	2,27 J/L
EBD	Ethanol	25 mg/m3	6 kV	50 KHz	70%	3,56 J/L
DBD	Ethanol	25 mg/m3	25 kV	50 KHz	55%	28 J/L

(No optimized results)

Surface quantity of 30mg.m-3 ethanol degraded (6kV, 50 Hz, 5% HR)

With ELECTROCERAMIC BARRIER DISCHARGE EBD by prodea:
depolluting

Q = 1,12 ppm.cm-2

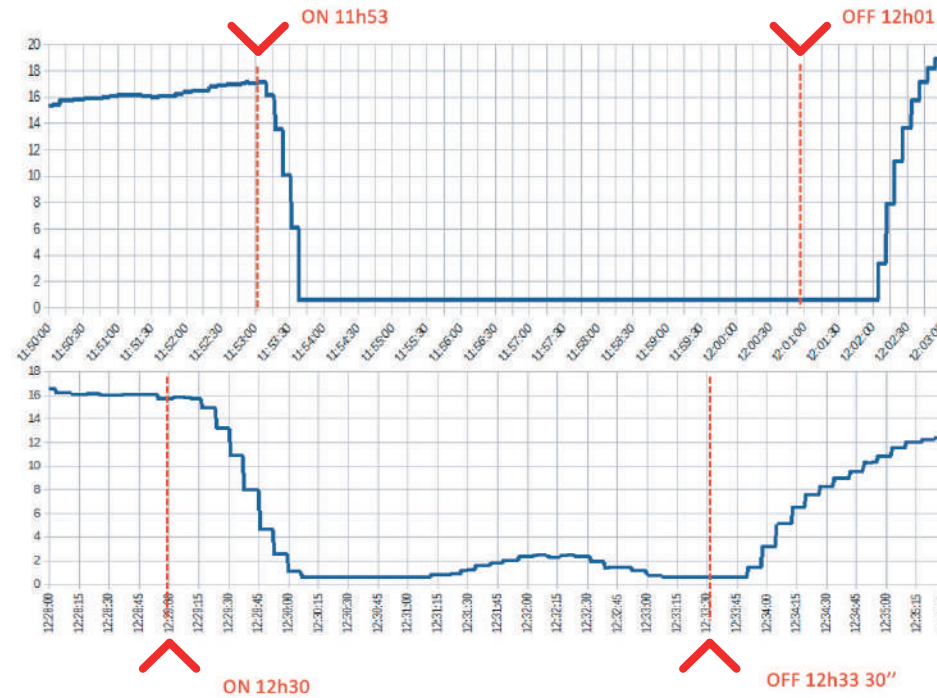
With DIELECTRIC BARRIER DISCHARGE DBD (GLASS) :

Q= 0,0015 ppm.cm-2

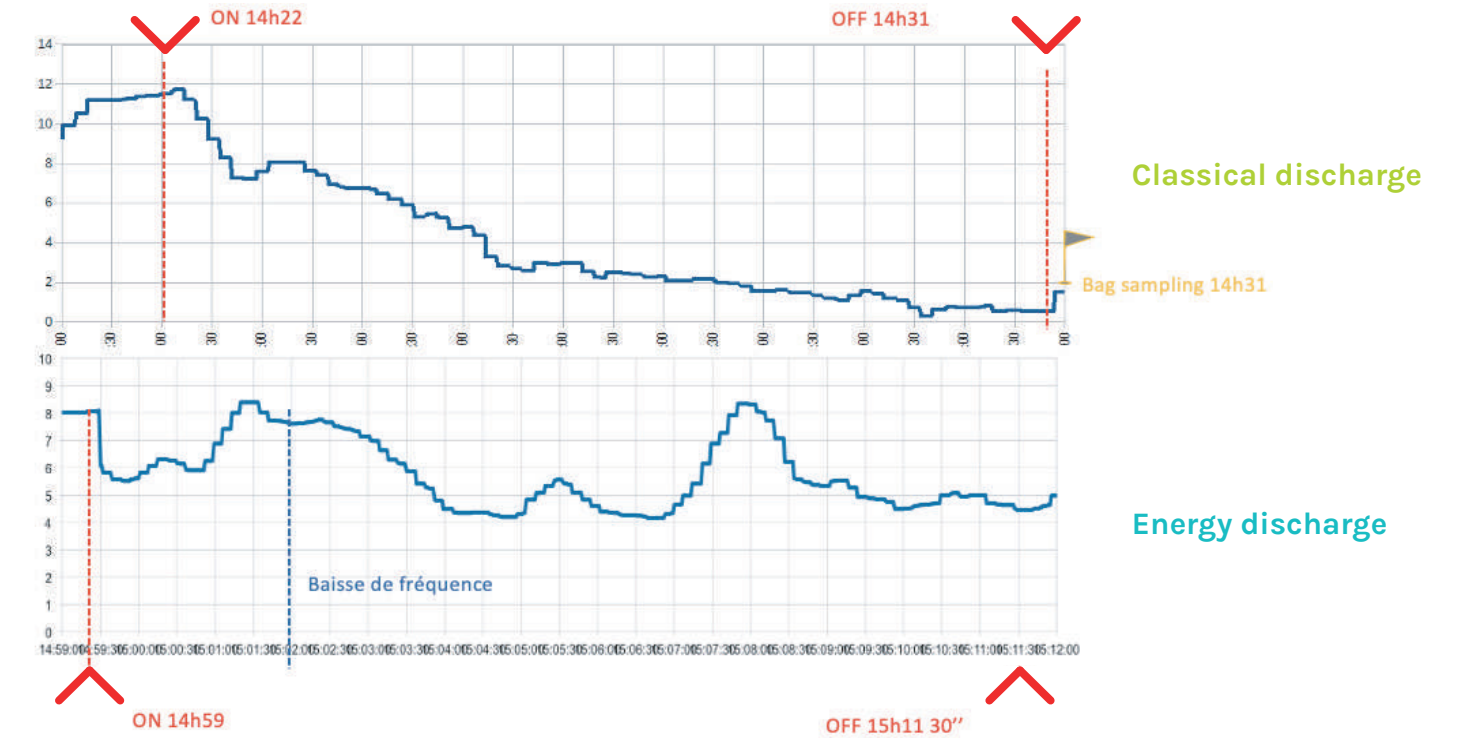


Chemical characterization

01 20ppm H₂S



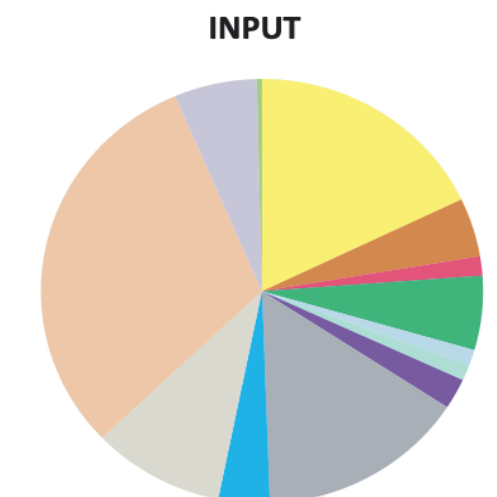
02 In situ: waste water treatment plant (H₂S targeted)



When we have only H₂S we can see that it is easily and instantly destroyed by classical discharges, and we see that its destruction is delayed but effective with energetic discharges too.

With the real flow rate, more than 150 compounds are present, competition effects take place. Certain pollutants are preferentially degraded by a particular discharges regime (as we already saw before)

Based on this observation, we took samples and were able to refine our knowledge of the effects of different discharges on the different families of pollutants and then design an optimized reactor.

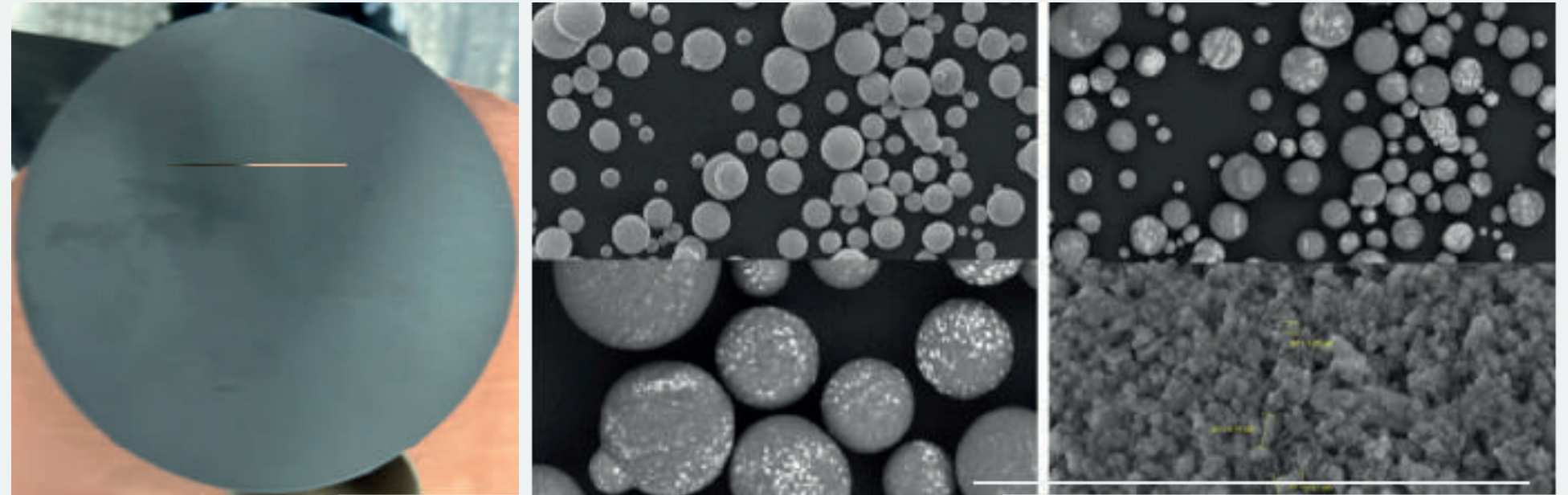


Prodea Depolluting Reactor

The core of Prodea Depolluting Non-Thermal Plasma reactor is made from a novel discharge plasma material, an Electroceramic, used as Barrier. This material presents specific electrical properties which are tunable, according to the needs of different applications.

This is made possible thanks to our R&D work, which deal with all the steps of the electroceramic fabrication process (2 key patents):

- The original processing route of the ceramic powder composite.
- The setting-up of the densification technology (sintering technology).



Placed in a specifically designed reactor (1 patent), this Electroceramic barrier (2 patents), allows outstanding plasma properties which stem from the particular microstructure of this barrier. This combination provides a technological

breakthrough, that is well illustrated by the achievement of high abatements as well as energy efficiency, all with extreme compactness, and no harmful by-products.

We insert electroceramics with controlled microstructures adapted to the electrical signal and the targeted pollution.

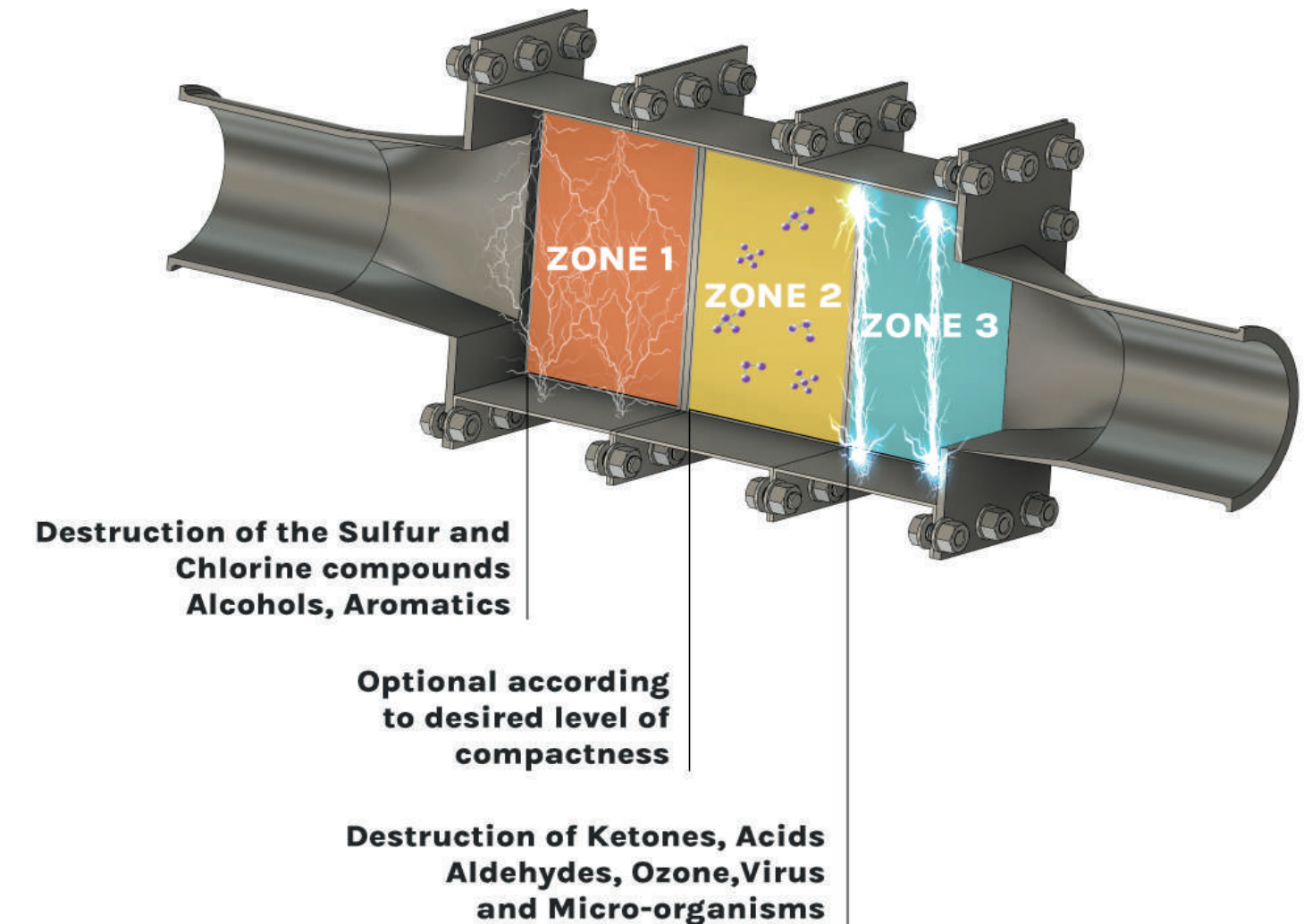
It is possible to involve all discharge regimes in order to obtain the best possible treatment. We observed that each discharge regime (classical or energy) is preferentially effective on families of pollutants: this is the genesis of our multi-zone reactor

How does it work ?

When the gas loaded with a mixture of chemicals and micro organisms enters the reactor, it begins stage 1 in which certain molecules are destroyed.

The mixture then modifies passes into stage 2, free of energy, in which the reactions favored by long-life species and ozone continue.

And finally it passes into stage 3, in which the recalcitrant species, the by-products, and ozone are instantly destroyed.



We can completely modulate the distribution of zones and their dimensions in order to allow optimal treatment. We thus obtain a system which easily adapts to the pollution to be treated, tailor-made, whereas plasma is generally not a selective technology.