

## Do Dielectric Materials exist?

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Materials in itself are not that important for electric insulation as engineers usually think. This can be seen from the fact that the intrinsic strength of materials is in the order of a megavolt per mm (fig. 1), whereas stresses in service are of the order of 3 to 10 kV/mm.

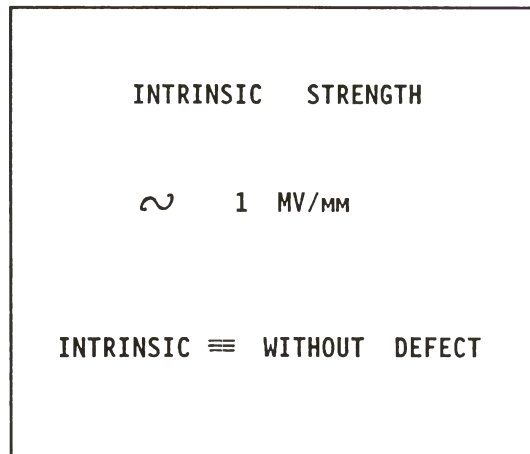


Figure 1

This large different is caused by defects in materials (some are shown in fig. 2) and these defects are inevitable.

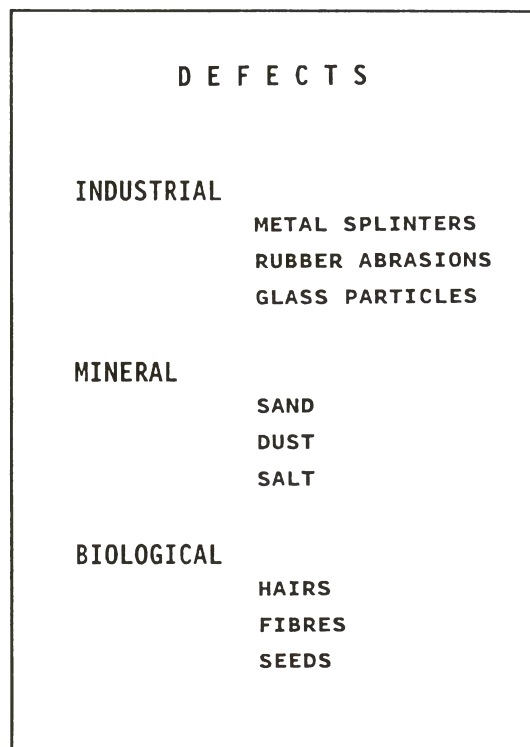


Figure 2

The most common defects are the inclusions of foreign matter, which can be divided in **industrial**, **mineral** and **biological** particles (see fig. 3).

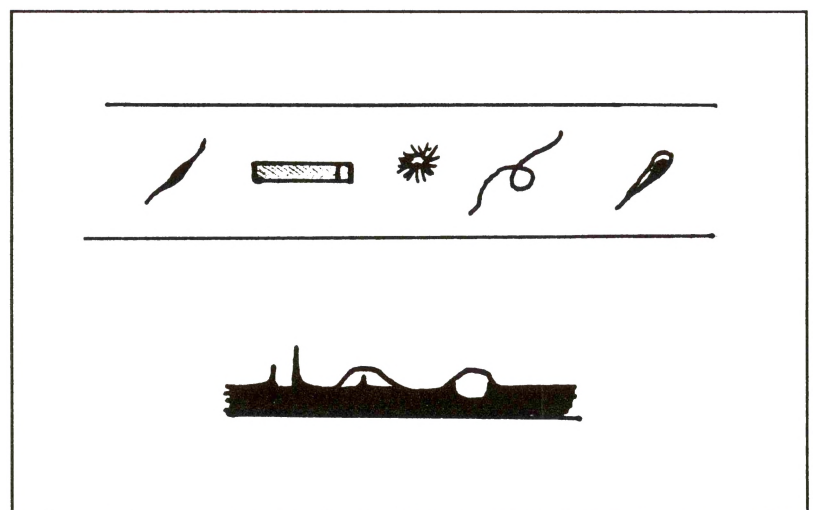


Figure 3

Another important type of defect is the cavity. The discharge phenomena (as shown in fig. 4) are well-known and need not be to the discussed in this audience of connaisseurs.

A far less frequent defect is the water-tree, generally of importance to cable-makers. The mechanism of initiation and growth has recently become known (see fig. 5) and forms an interesting case of electro-chemical aging.

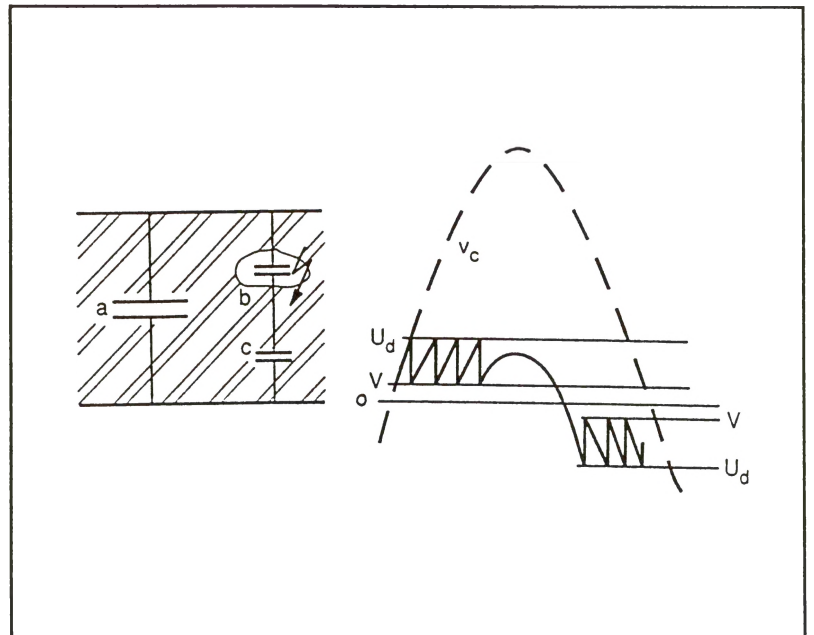


Figure 4

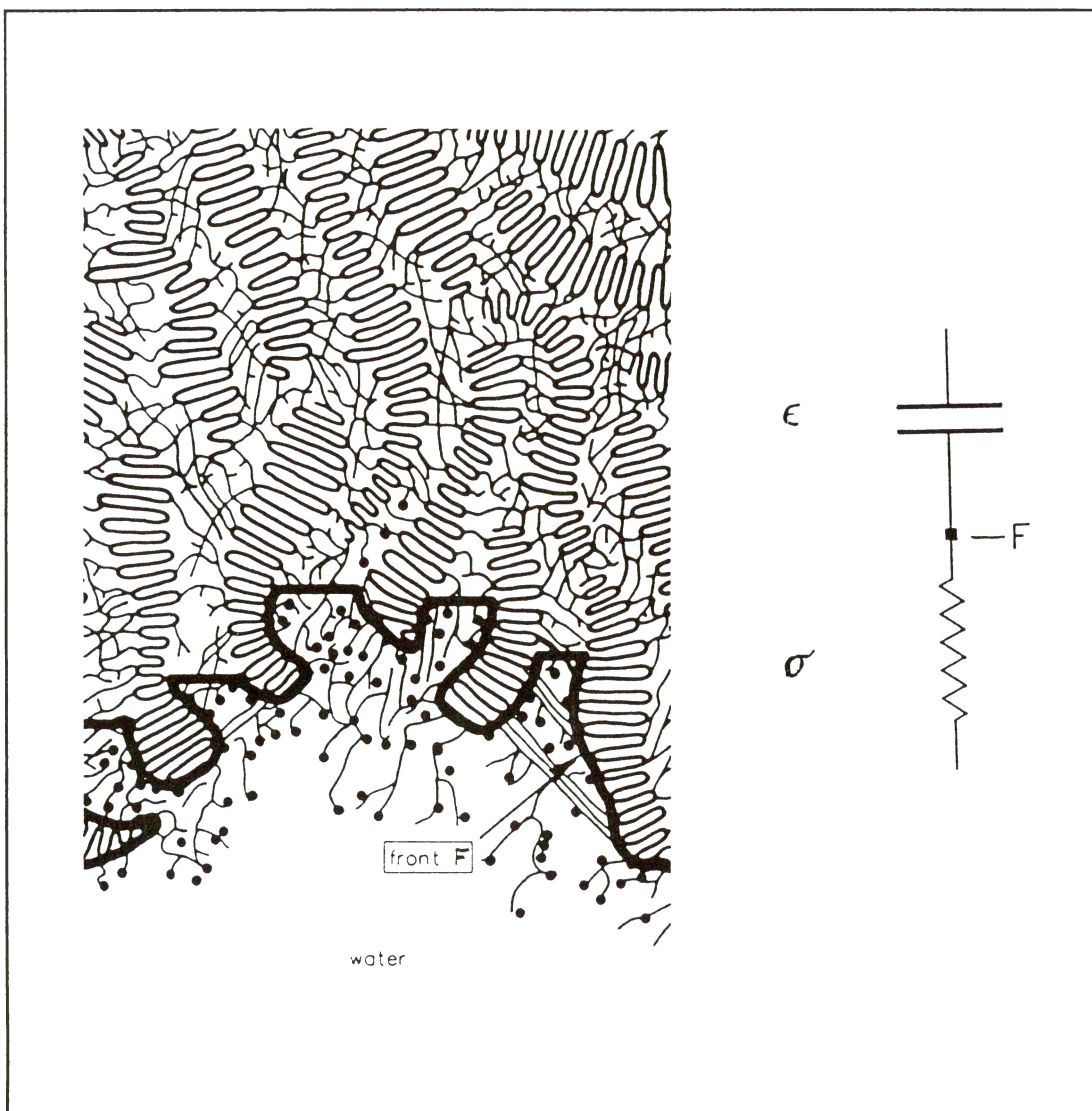


Figure 5

A defect that often is seen as a con-  
structional detail, but in fact forms a  
defect as seen by the electric field is  
the interface between dielectrics (see  
for instance fig. 6). These interfaces  
form actually important weak spots in  
a dielectric structure and shall both be  
controlled by a good design and intensi-  
vely be tested for production quality.

Most of the defects mentioned here  
cause partial discharges and all of them  
shown partial discharges (often quite  
heavy ones) just before breakdown.  
Discharge detection is thus an important  
technique for testing for these defects.  
The techniques for checking the  
presense of discharges are well-known  
and (again) need not to be discussed in  
this audience. If these techniques are  
used in the right manner they result in  
two observations:

- (a) discharge magnitude (if any) as a  
function of voltage and
- (b) a discharge pattern as a function  
of the 50 Hz sine wave (see fig. 7).

Diagram (a) gives in fact the largest  
discharge present and forms an  
excellent base for "go" "no go"  
decisions. If a high voltage construction  
agrees with the discharge requirements  
as specified this construction passes  
the test and is accepted by the user.  
However, if it exceeds the discharge  
limit a problem is born. The  
manufacturer wants to know what is  
wrong with his construction, the user  
wants to know whether the discharge  
was really a danger for the voltage life  
of the product.

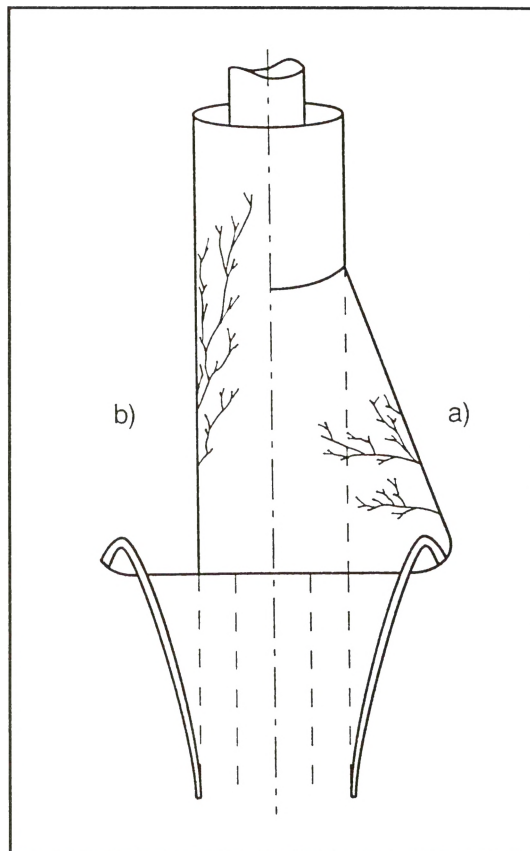


Figure 6

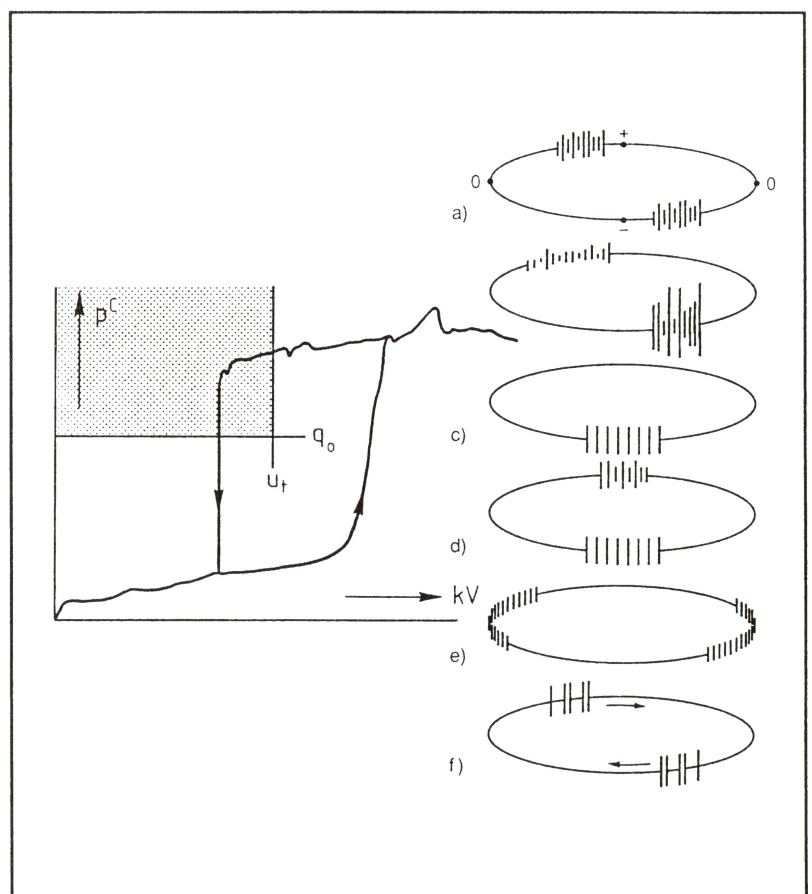


Figure 7

Up till now the well-known discharge patterns on the elliptical time-base give **some** information, but not sufficiently.

Research work carried out in recent years and still being in progress has shown that **statistical** analysis of these

discharge patterns promises to be an excellent technique for answering these questions. The University of Delft, together with Haefely in Basel, have gone far in this field; some of these results will be shown in this symposium.