DuPont™ Kapton®

Polyimide Film
Products of Decomposition

Studies by DuPont and others have demonstrated the outstanding thermal stability of polyimide film and the dependence of the rate of degradation upon the availability of oxygen. In air at about 500°C (932°F), Kapton® polyimide film decomposes and completely disappears after 12 hours. While in a vacuum or in an inert atmosphere, 60 to 65% of the film remains after prolonged aging at temperatures as high as 1000°C (1832°F). This remaining residue retains its original shape but has lost all of its mechanical strength.

Mass spectrometric analysis of the gaseous decomposition products of Kapton® in a closed system under vacuum showed the principal products were carbon dioxide and carbon monoxide. The substances identified and their relative amounts follow. This data differs from that reported by Bruck (Refs. 1 to 6) primarily with regard to the presence of gases with low boiling points, e.g., carbon monoxide and hydrogen. This difference is the system used was closed off before pyrolysis, while Bruck continued to maintain constant pressure by pumping. Bruck also found a considerably higher water content, possibly reflecting different drying procedures before pyrolysis.

In addition to the gaseous products, which accounted for 40 to 60% of the weight loss, a substantial amount of liquid and solid was collected. This material has not been completely characterized, but is known to contain amino, phenolic and phthalimide groups.

Mass Spectrometric Analysis of Gaseous Degradation Products of Kapton® HN Film

Vacuum Pyrolysis at 540°C for 2 hours

Component	Mole, %
Benzene	0.7
Carbon Dioxide	35.1
Carbon Monoxide	58.7
Water	1.2
Ammonia	Trace
Hydrogen Cyanide	1.2
Benzonitrile	0.5
Wt. loss on sample	34.6%
Original sample wt.	0.4382 g.

What would actually be produced from the combustion of Kapton® in a fire would depend on the precise conditions of combustion. The nature and quantity of combustion products may change radically as a fire develops. For this reason, we are not able to predict with any accuracy what would actually be produced and in what quantity. In general, based on its chemical composition, complete combustion of Kapton® Type HN (100% polyimide file) would yield carbon dioxide, water and nitrogen oxides (NO) in a mole ration of 22:5:1.

References

Thermal Degradation of Polyimides

1. *S.D. Bruck, ACS Polymer Reprints, 5(1).* April 1964, P. 148-152
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3. *S.D. Bruck, In "Vacuum Microbalance Techniques", Vol. 4*, Ed by P.M. Waters, New York, Plenum Press (1964), P. 249
4. *S.D. Bruck, Polymer 5 (9)*, 435-46 (1964)
5. *S.D. Bruck, Polymer 6 (1)*, 49-61 (1965)
6. *S.D. Bruck, Polymer 6 (6)*, 319-32 (1965)

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