Accepted Manuscript

The influence of oxygen on thermal decomposition characteristics of epoxy resins cured by anhydride

Xiaoxing Zhang, Yunjian Wu, Hao Wen, Guoxiong Hu, Zilai Yang, Jingsong Tao

PII: S0141-3910(18)30267-2

DOI: 10.1016/j.polymdegradstab.2018.08.006

Reference: PDST 8619

To appear in: *Polymer Degradation and Stability*

Received Date: 28 May 2018

Revised Date: 22 July 2018

Accepted Date: 10 August 2018

Please cite this article as: Zhang X, Wu Y, Wen H, Hu G, Yang Z, Tao J, The influence of oxygen on thermal decomposition characteristics of epoxy resins cured by anhydride, *Polymer Degradation and Stability* (2018), doi: 10.1016/j.polymdegradstab.2018.08.006.

The Influence of Oxygen on Thermal Decomposition Characteristics of Epoxy Resins Cured by Anhydride

Xiaoxing Zhang, Yunjian Wu, Hao Wen Guoxiong Hu, Zilai Yang , Jingsong Tao *

School of Electrical Engineering, Wuhan University, Wuhan 430072, China ,

Abstract: Anhydride cured epoxy resins are always used as pivotal solid insulation medium in many electrical equipment, which will decompose due to the high temperature caused by partial discharge and the presence of oxygen will aggravate this process. In order to explore the influence of oxygen on the thermal decomposition characteristics of epoxy resin cured by anhydride, simulation models are established in this paper. The ReaxFF force field is used to simulate the pyrolysis process of epoxy resin and the changes in production of small molecular gases (such as CO_2, H_2O, CO and CH_2O), and C_2, C_3 are discussed. The results show that the oxygen will affect the main chain of the epoxy resin by introducing a carbon-oxygen double bond to the tertiary carbon atom attached to oxygen atom. Meanwhile, with the presence of oxygen, all the products' initial generation time will be earlier, the amount of CO_2 will increase, the amount of H_2O will go up dramatically while that of CH_2O remain basically unchanged, the types and quantities of C_2 and C_3 products increase obviously, mainly reflected in the oxygenated products.

Keywords: oxygen; epoxy resins; ReaxFF force field; thermal decomposition

1. Introduction

Anhydride cured epoxy resins are widely used in electrical equipment such as GIS, transformer, switchgear and cable termination because of its favorable insulating properties [1-2]. However, these resins are inevitable to defects, such as pits, contamination and metal particles during their manufacture, transportation, and operation because of electric, heat, and mechanical stresses. These defects render the surface of epoxy resins vulnerable to partial discharge, which can lead to an average temperature rise of 170 °C and maximum of 1000 °C around a volume of 5×10^{-11} cm^3 on the epoxy resin surface near the partial discharge area [3-6]. High temperature can result in the decomposition of epoxy resin and seriously deteriorate their insulating and mechanical performance, and the presence of oxygen will aggravate this process [7-8].

Huy et al [9-11] conducted a series of studies on the thermos-oxidative aging of anhydride cured epoxy resin. They found that the process brings down the glass transition temperature and produces oxidized resultants, of which the depth follows an exponential distribution, the mass of the resins decrease by the quasi-hyperbolic function at the same time. Under the thermo-oxidative degradation, the aging process, crack growth and their interaction of epoxy resin were investigated by X. Colin et al. It was found that the crack will occur on the surface when the brittles of the oxide layer reaches a critical value [12-14]. J. Decelle [15] et al studied the mechanism of oxygen's effect on the network shrinkage during the thermal aging of aromatic diamine-cure bisphenol F epoxy resins and found that oxidizing the branched radical chain generated by the monomolecular decomposition of hydroperoxides is the main