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IMPROVEMENT OF PROPERTIES OF POLY(P-PHENYLENE PYROMELLITIMIDE) VIA INCORPORATION OF SHORT SIDE GROUPS, S.L. KIM, T.J. SHIN, S.M. PYO, and M. REE,\* (Dept. of Chemistry, Polymer Research Institute, Pohang Univ. of Sci. & Technol., Pohang 790-784 Korea)

Fully rodlike poly(p-phenylene pyromellitimide) (PMDA-PDA) exhibits high modulus, low thermal expansion, and low residual stress, but is counted as a useless dielectric polymer because of the high brittleness. In order to improve the brittleness without suffering of its advantageous properties, a series of soluble poly(p-phenylene pyromellitic acid)s containing methyl, methoxy and trifluoromethyl as side groups were synthesized and thermally converted to the polyimides in thin films through conventional spin-cast, softbake and imidization process. The polyimide films were characterized by X-ray diffraction, prism-coupling, static and dynamic thermomechanical analysis, residual stress analysis, and stress-strain analysis. The brittleness of PMDA-PDA polyimide was healed significantly by the incorporation of methyl, methoxy and trifluoromethyl as side groups, without significant degrading of other properties. In this study, it has been demonstrated that the mechanical brittleness in a rodlike polymer can be solved by the incorporation of short side groups with keeping the advantageous properties. The measured properties will be discussed in detail with considering structures, side group, and film formation history. [This study was supported by KOSEF (Contract Nos. 95-0501-08-01-3 & 961-0301-006-2) and by the New Materials Research Fund in 1997 from the Ministry of Education].

## P-142

IMIDIZATION-INDUCED STRUCTURE EVOLUTION IN POLY(4,4'-OXYDIPHENYLENE PYROMELLITIMIDE): A SYNCHROTRON X-RAY SCATTERING STUDY, X. WANG, T.J. SHIN, I.-J. LEE, and M. REE,\* (Dept. of Chemistry, Polymer Research Institute, & Pohang Accelerator Laboratory, Pohang University of Sci. & Technol., Pohang 790-784 Korea)

Poly(4,4'-oxydiphenylene pyromellitimide) (PMDA-ODA) is widely used in the microelectronic industry as dielectric interlayers, passivation layers, and alpha-particle barriers. The polymer is insoluble so that it is always processed as its soluble precursor forms such as poly(amic acid) (PAA) and poly(amic dialkyl ester) (PAE). Both the precursors are finally converted thermally or chemically to the polyimide. In particular, the thermal imidization process requires a high temperature of  $>300^{\circ}\text{C}$ , so that the structural evolution occurred during the imidization could not be investigated easily. In this study, we have attempted to examine the structural evolution induced by the thermal imidization using the X-ray scattering technique with synchrotron radiation sources. X-ray scattering measurements were carried out isothermally and non-isothermally over 25-400°C. The structural evolution was detected to be initiated at ca. 130°C for the PAA and at ca. 180°C for the PAE. That is, the structural evolutions of the precursors are found to be started at the onset temperatures of imidizations and accelerated by increasing temperature. The results will be discussed in detail in the relationship of structural evolution and imidization kinetics. The structural evolution is further correlated to the properties in the resultant polyimide. [This study was supported by KOSEF (Contract Nos. 95-0501-08-01-3 & 961-0301-006-2) and by the New Materials Research Fund in 1997 from the Ministry of Education].

## P-143

MORPHOLOGICAL STRUCTURE OF POLY(P-PHENYLENE BIPHENYLTETRACARBOXIMIDE): A TIME-RESOLVED X-RAY SCATTERING STUDY USING SYNCHROTRON RADIATION SOURCES, T.J. SHIN, S.W. LEE, X. WANG, I.-J. LEE, and M. REE,\* (Dept. of Chemistry, Polymer Research Institute, & Pohang Accelerator Laboratory, Pohang University of Sci. & Technol., Pohang 790-784 Korea)

Poly(p-phenylene biphenyltetracarboximide), the 2nd generation of high performance polyimide, is widely used in the microelectronic industry as dielectric interlayers, passivation layers, and alpha-particle barriers. However, the structural formation in the polymer has been rarely investigated. In this study, its soluble poly(amic acid) (PAA) and poly(amic dialkyl ester) (PAE) were synthesized and then converted thermally to the polyimides. Time-resolved X-ray scattering measurements were performed during both isothermal and non-isothermal imidization of the precursors over 25-400°C. The structural evolutions of the precursors are found to be started at the onset temperatures of imidizations and accelerated by increasing temperature. The results will be discussed in detail in the relationship of structural evolution and imidization kinetics. The structural evolution is further correlated to the properties in the resultant polyimide. [This study was supported by KOSEF (Contract Nos. 95-0501-08-01-3 & 961-0301-006-2) and by the New Materials Research Fund in 1997 from the Ministry of Education].

## P-144

SURFACE ACTIVATED BONDING AT ROOM TEMPERATURE USING 266nm Nd-YAG LASER

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Nd-YAG laser ( $\lambda=266\text{nm}$ ) was used to study the effect of surface activation for the surface activated bonding (SAB) method at room temperature. Activated surface is acquired by the removal of the native oxide and surface contamination. Cu and Sn surfaces irradiated by Nd-YAG laser in ultrahigh vacuum (UHV) were first studied using x-ray photoelectron spectroscopy (XPS). It was found that the native oxide removal of both samples takes place after laser irradiation (125mJ/cm<sup>2</sup>, 30min, 20Hz pulses). However, the surface modification induced by laser irradiation was also observed at the same energy density and number of laser shot. After the laser induced surface activation treatment in UHV atmosphere, Cu and Sn were jointed successfully by the SAB method at room temperature. The tensile strength of Cu-Sn joint was 10 MPa.