SUPPLEMENTARY MATERIAL TO

Structural effects of the monomer type on the properties of copolyimides and copolyimide–silica hybrid materials

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Fig. S-1. FTIR spectrum of bis[4-(3-aminophenoxy)phenyl]phenylphosphine oxide (m-BAPPO).

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Fig. S-2. $^1$H-NMR spectrum of bis[4-(3-aminophenoxy)phenyl]phenylphosphine oxide ($m$-BAPPO).

Fig. S-3. $^{31}$P-NMR spectrum of bis[4-(3-aminophenoxy)phenyl]phenylphosphine oxide ($m$-BAPPO).
Fig. S-4. FTIR spectrum of: a) BAPPO–3,3'-DDS/6FDA copolyimide; b) BAPPO–3,3'-DDS/6FDA/SiO₂ hybrid copolyimide; c) m-BAPPO–3,3'-DDS/6FDA copolyimide; d) m-BAPPO–3,3'-DDS/6FDA/SiO₂ hybrid copolyimide.

Fig. S-5. Storage ($E'$) modulus of: a) BAPPO–3,3'-DDS/6FDA copolyimide; b) BAPPO–3,3'-DDS/6FDA/SiO₂ hybrid copolyimide; c) m-BAPPO–3,3'-DDS/6FDA copolyimide; d) m-BAPPO–3,3'-DDS/6FDA/SiO₂ hybrid copolyimide as functions of temperature.

Fig. S-6. The tan δ values of the BAPPO–3,3'-DDS/6FDA copolyimide as a function of temperature.
Fig. S-7. The tan δ values of the BAPPO–3,3'-DDS/6FDA/SiO₂ hybrid copolyimide as a function of temperature.

Fig. S-8. The tan δ values of the m-BAPPO–3,3'-DDS/6FDA copolyimide as a function of temperature.

Fig. S-9. The tan δ values of the m-BAPPO–3,3'-DDS/6FDA/SiO₂ hybrid copolyimide as a function of temperature.
Fig. S-10. SEM image of: a) BAPPO–3,3'-DDS/6FDA copolyimide; b) m-BAPPO–3,3'-DDS/6FDA copolyimide; c) BAPPO–3,3'-DDS/6FDA/SiO$_2$ hybrid copolyimide; d) m-BAPPO–3,3'-DDS/6FDA/SiO$_2$ hybrid copolyimide; e) SEM–EDS image of BAPPO–3,3'-DDS/6FDA/SiO$_2$ hybrid copolyimide.
Scheme S-1. The synthesis route to bis[4-(3-aminophenoxy)phenyl]phenylphosphine oxide (m-BAPPO).
Scheme S-2. Preparation of copolyimide–silica hybrid films (DSS denotes 3,3’-DSS).
Scheme S-3. a and c) The chemical structure of the copolyimides; b and d) the chemical structure of the copolyimide–silica hybrids.