Sesamol based polybenzoxazines for ultra-low k, high-k and hydrophobic coating applications

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Supporting Information

S1 Preparation of functionalized bio-silica from bamboo grass

Bamboo grass was washed with distilled water and dried for 3 h at 60°C. After being treated with concentrated HCl to remove any impurities, the dried bamboo grass was continuously rinsed with water until the pH becomes neutral. After that it was placed in a muffle furnace for 5 h at 600°C to obtain bio-silica (SiO_2). Simultaneously, 4 ml of glycidylpropyltrimethoxysilane (GPTMS) in 95% absolute ethanol and 5% deionized water was added and sonicated for 20 minutes. Acetic acid was used to initially lower the pH of the above solution to 4.5, then continued sonication for an hour. Followed by 10 g of bio-silica obtained from bamboo grass was added, then the mixture was refluxed for 24 h at 80°C to obtain functionalized bio-silica. The product was centrifuged and washed with water followed by ethanol/hexane and then dried in a hot air oven at 80°C to remove the moisture (Scheme 5).

S2 Synthesis of the graphitic carbon nitride (GCN)

Synthesis of GCN was carried out by the direct heating of melamine in a muffle furnace. For this synthesis, 10 g of melamine was placed in an alumina crucible and heated up to 600°C for 4 h. After 4 h, the yellow GCN precipitate was formed, which was cooled to room temperature and subsequently collected for use in the next step.

FTIR spectral analysis cardanol functionalized GCN

According to the Fig.S1, the peak for pure graphitic carbon nitride (GCN) at 809 cm^{-1} can be attributed to triazine units and the peaks at 1540 and 1635 cm^{-1} can be related to C=N stretching. Also the peaks at 1234, 1317 and 1399 cm^{-1} can be attributed to aromatic C-N stretching. The relatively broad peak in 3100-3260 cm^{-1} can be related to terminal NH_2 or NH groups of the aromatic ring. The peak at 930 cm^{-1} represents the formation of oxazine ring in the cardanol functionalized graphitic carbon nitride (GCN-c). Further the peaks in the region of 2952-2817 cm^{-1} shows the presence of side chain aliphatic C-H stretching vibrations which supports the utilization of cardanol towards functionalization.

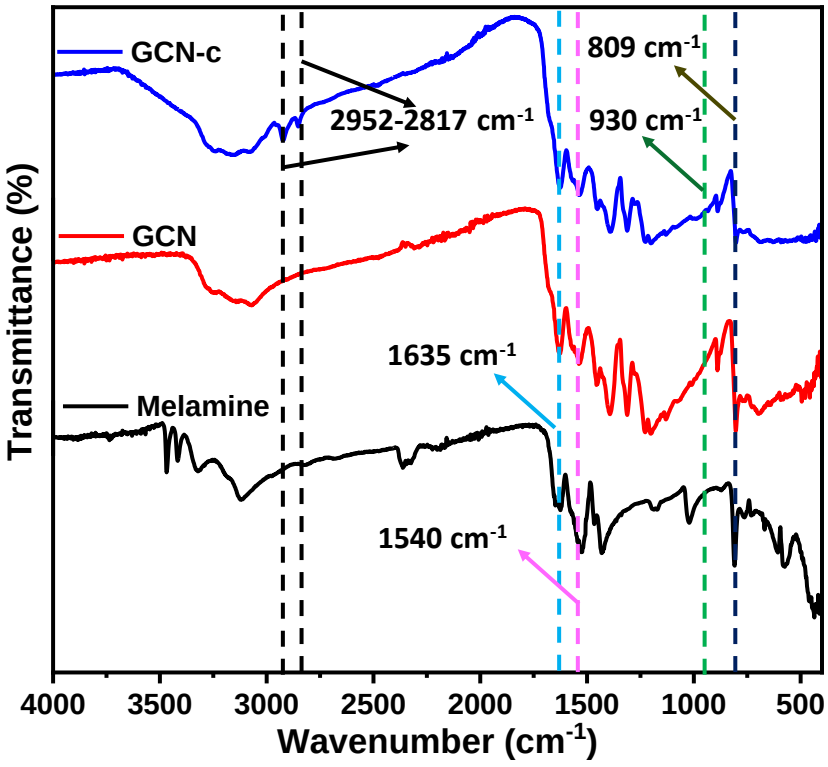

Fig. S1 FTIR spectra of (a) mealmine (b) synthesized graphitic carbon nitride (c) GCN-c

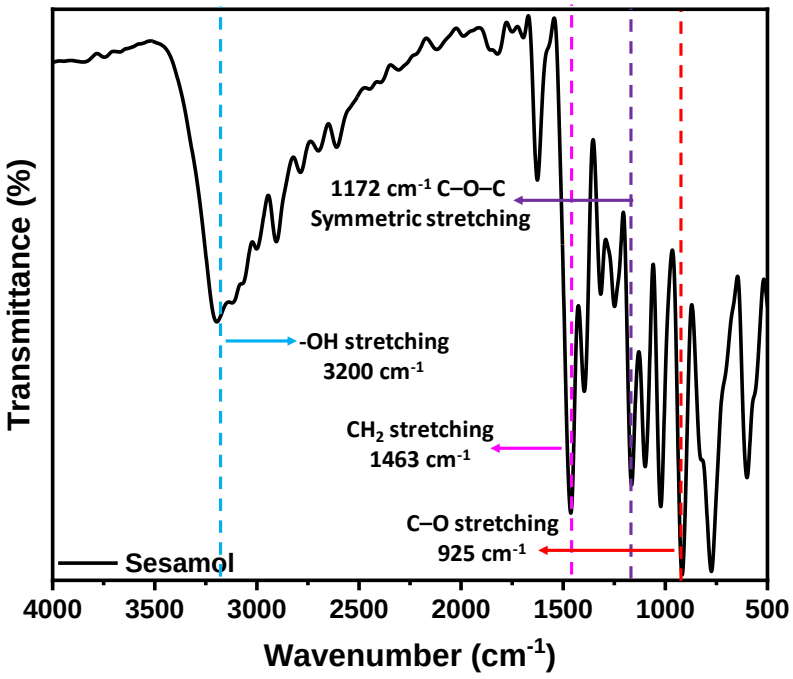

Fig. S2 FTIR spectrum of sesamol

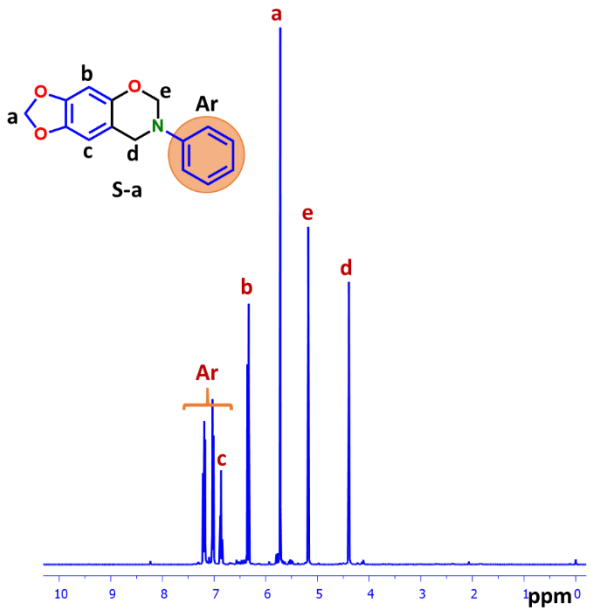

Fig. S3 ^{1}H-NMR spectrum of S-a benzoxazine monomer

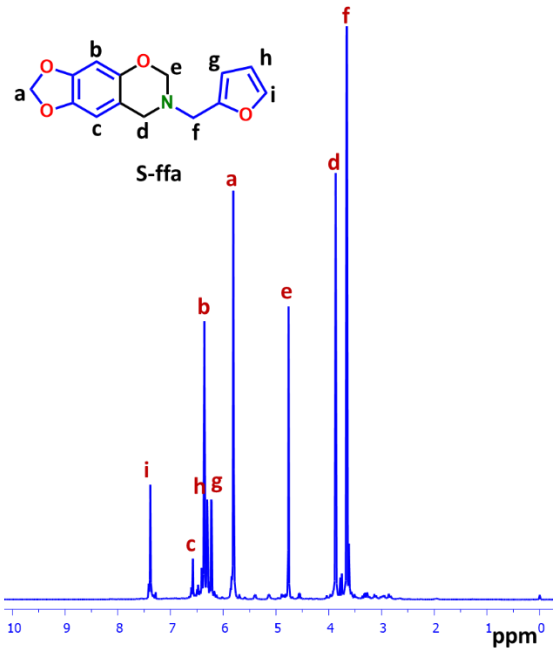

Fig. S4 ^{1}H-NMR spectrum of S-ffa benzoxazine monomer

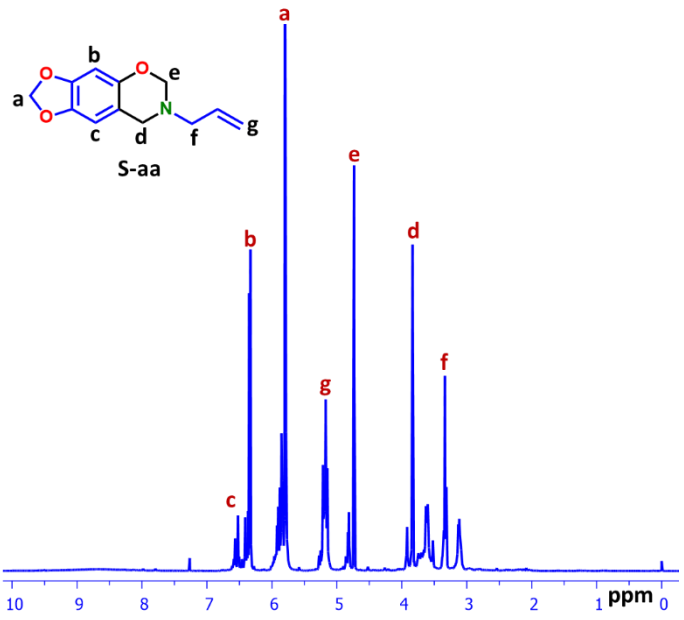

Fig. S5 ^{1}H-NMR spectrum of S-aa benzoxazine monomer

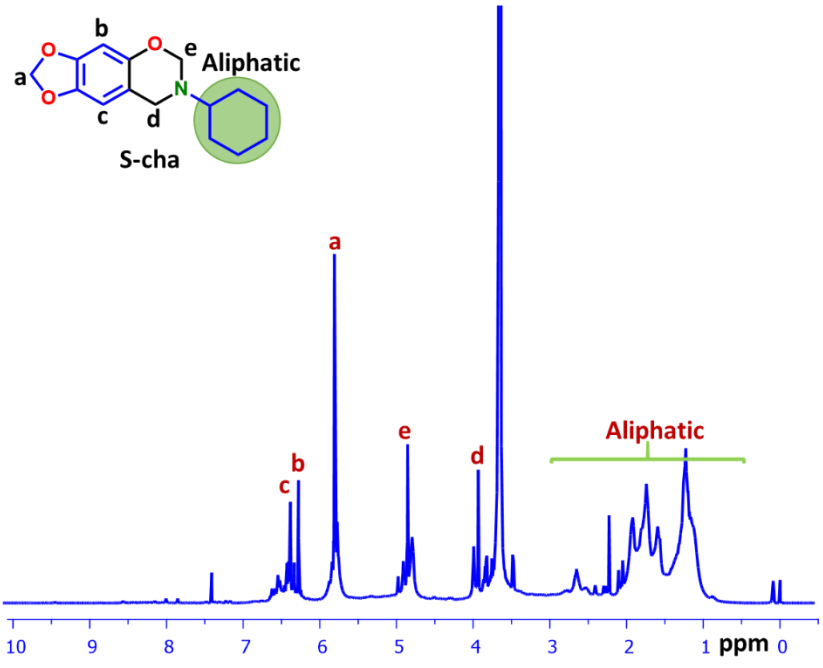

Fig. S6 ^{1}H-NMR spectrum of S-cha benzoxazine monomer

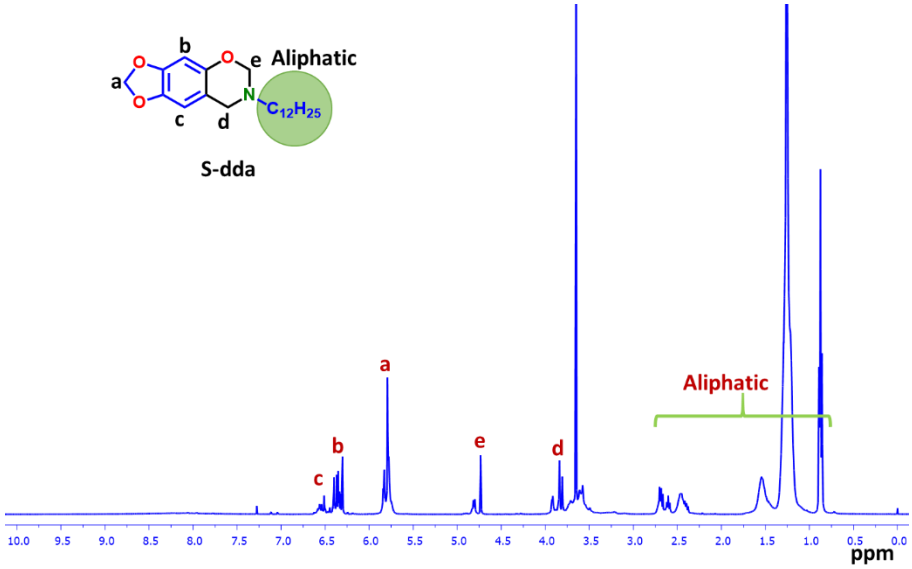

Fig. S7 ^{1}H-NMR spectrum of S-dda benzoxazine monomer

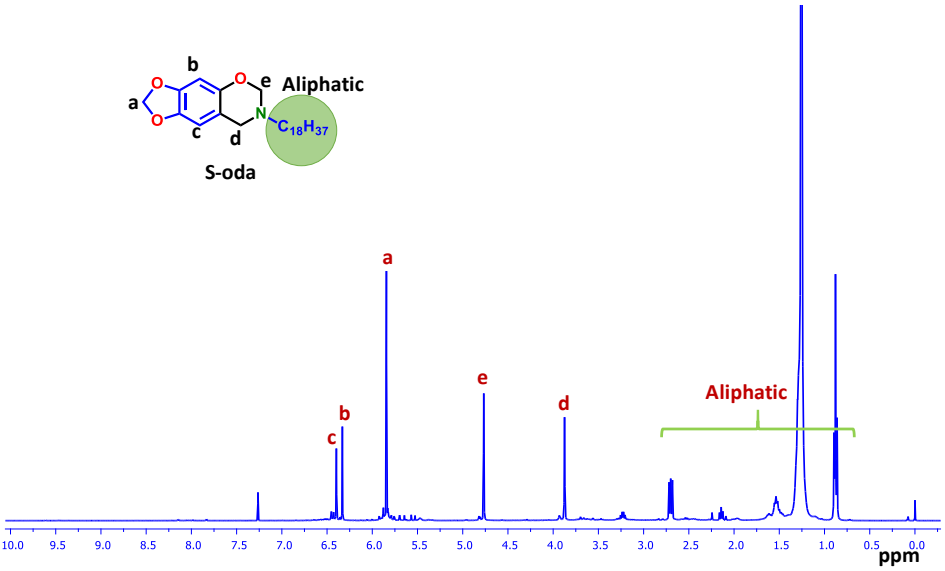

Fig. S8 ^{1}H-NMR spectrum of S-oda benzoxazine monomer

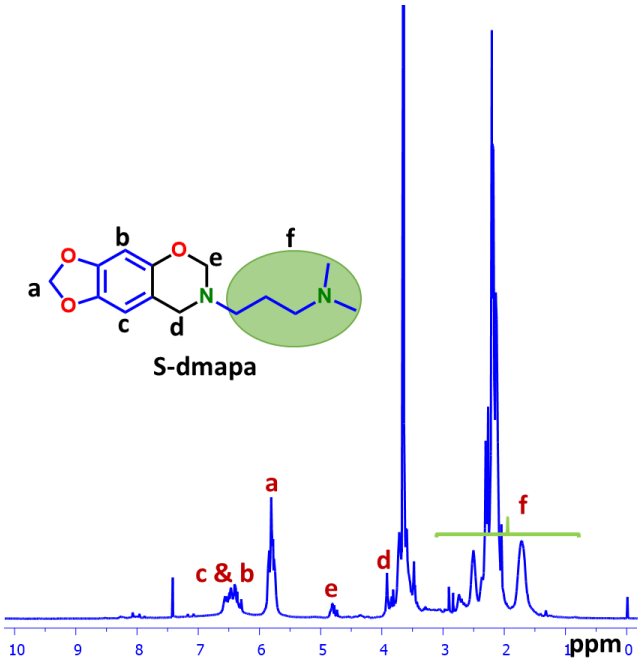

Fig. S9 [1]H-NMR spectrum of S-dmapa benzoxazine monomer

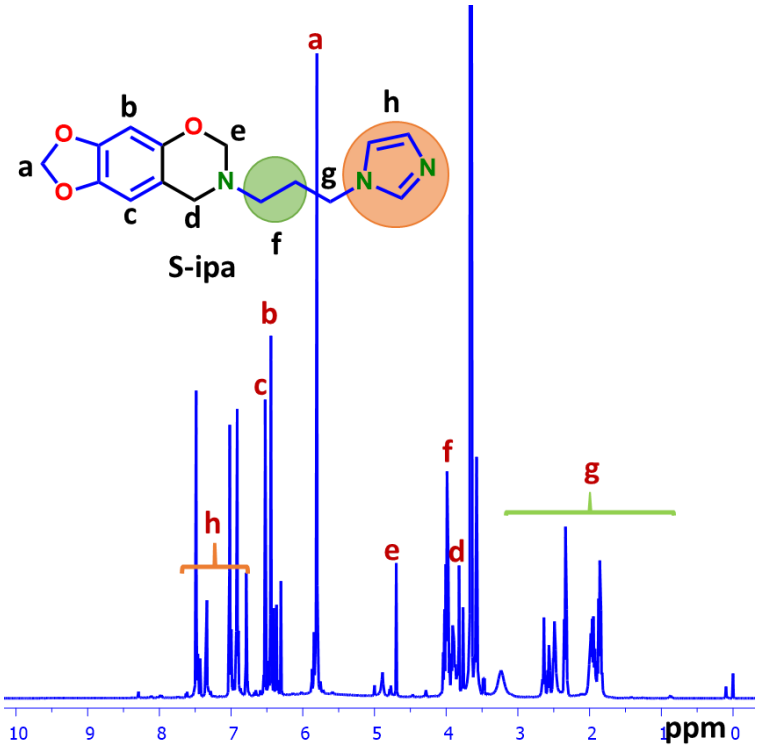

Fig. S10 [1]H-NMR spectrum of S-ipa benzoxazine monomer

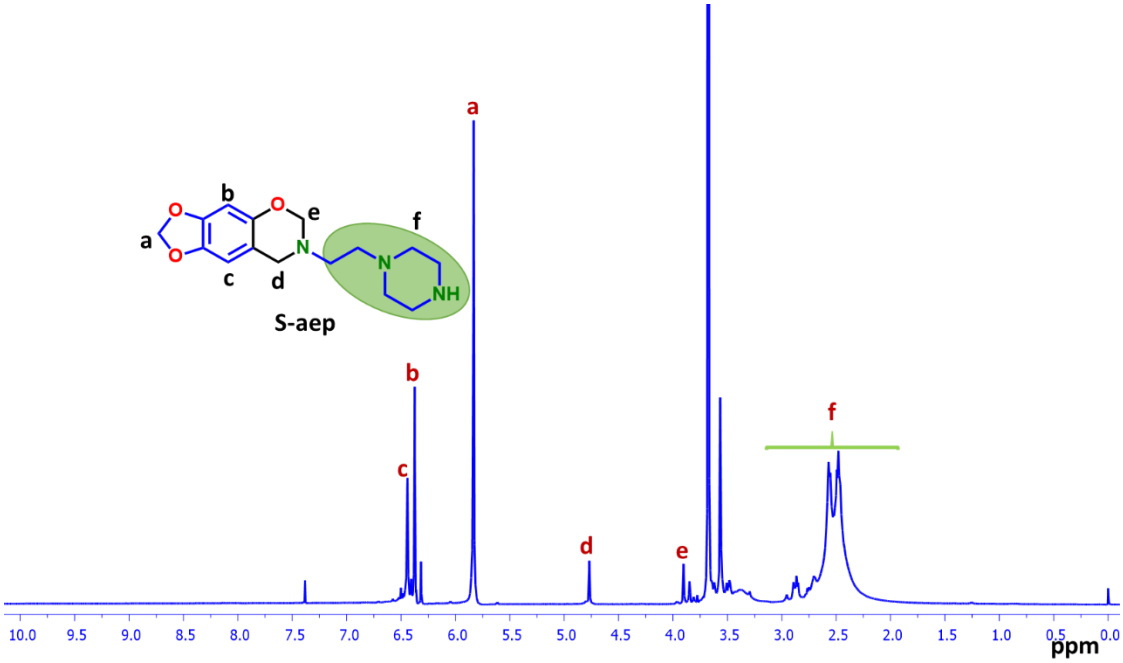

Fig. S11 ^{1}H-NMR spectrum of S-aep benzoxazine monomer

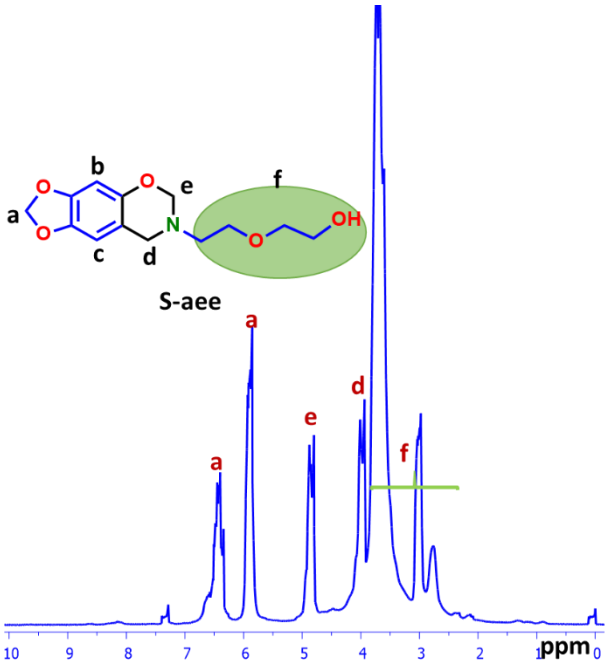

Fig. S12 ^{1}H-NMR spectrum of S-aee benzoxazine monomer

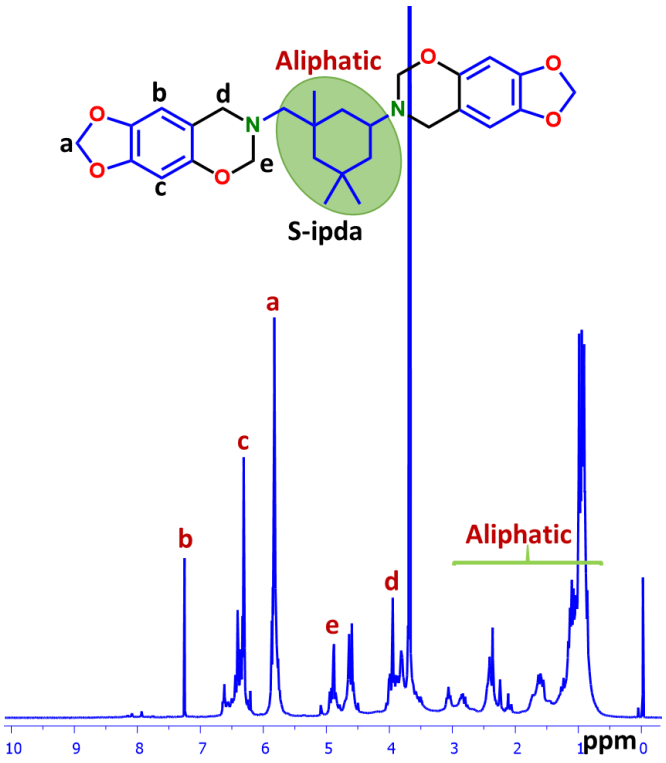

Fig. S13 ^{1}H-NMR spectrum of S-ipda benzoxazine monomer

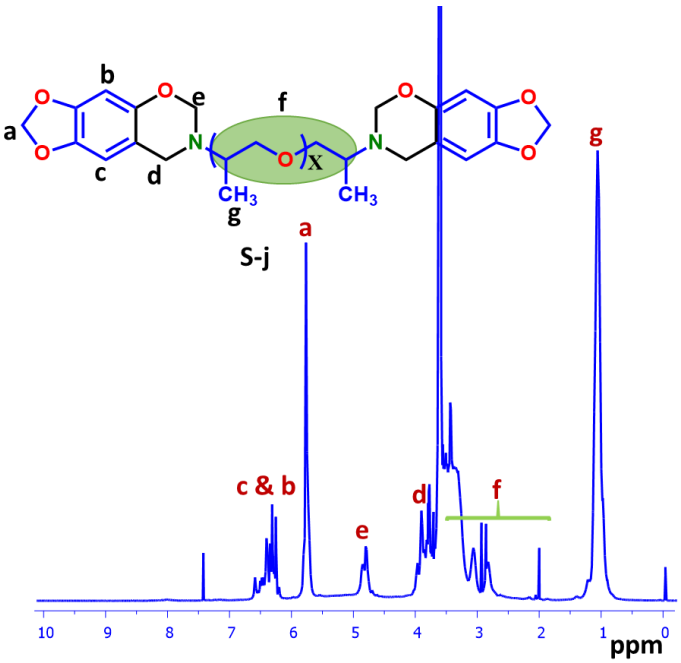

Fig. S14 ^{1}H-NMR spectrum of S-j benzoxazine monomer

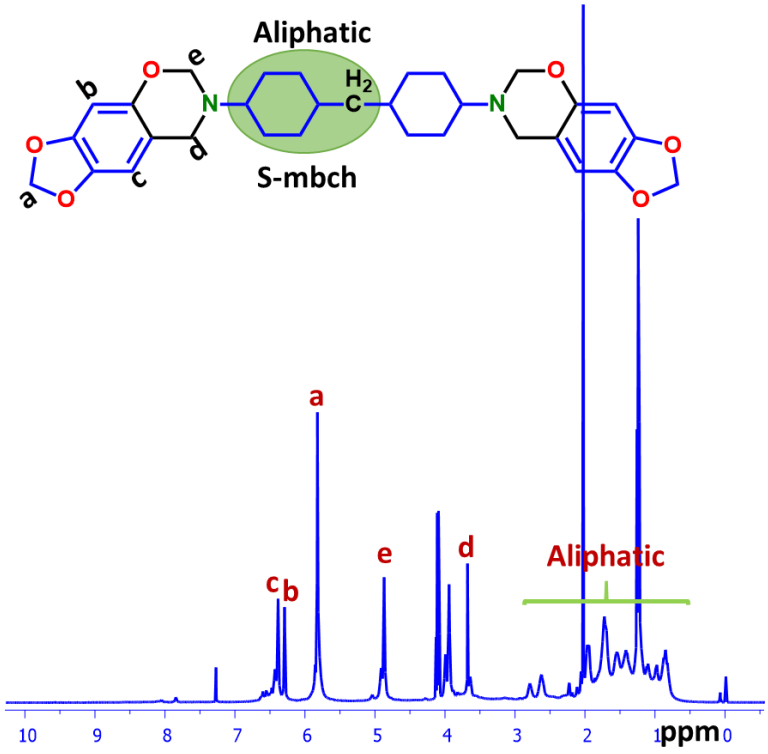

Fig. S15 ^{1}H-NMR spectrum of S-mbch benzoxazine monomer

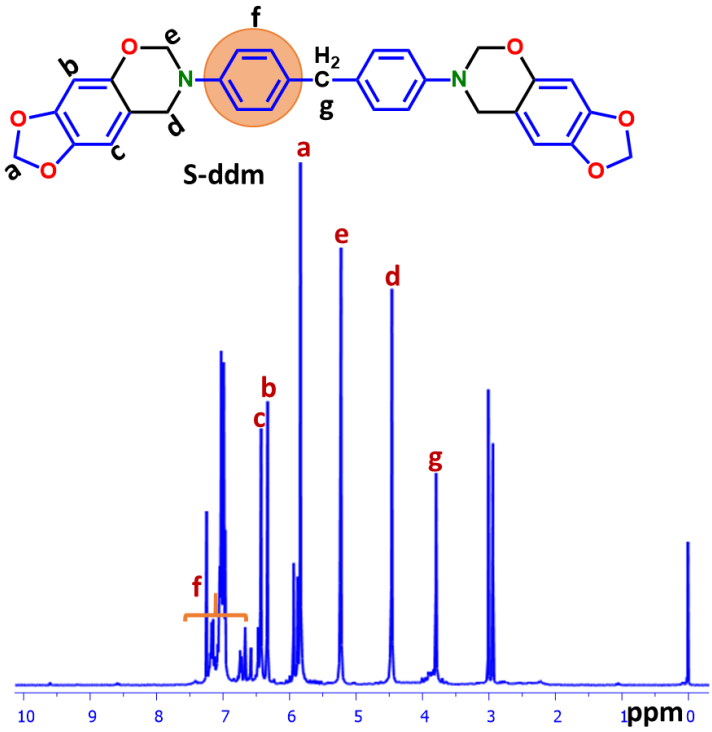

Fig. S16 ^{1}H-NMR spectrum of S-ddm benzoxazine monomer

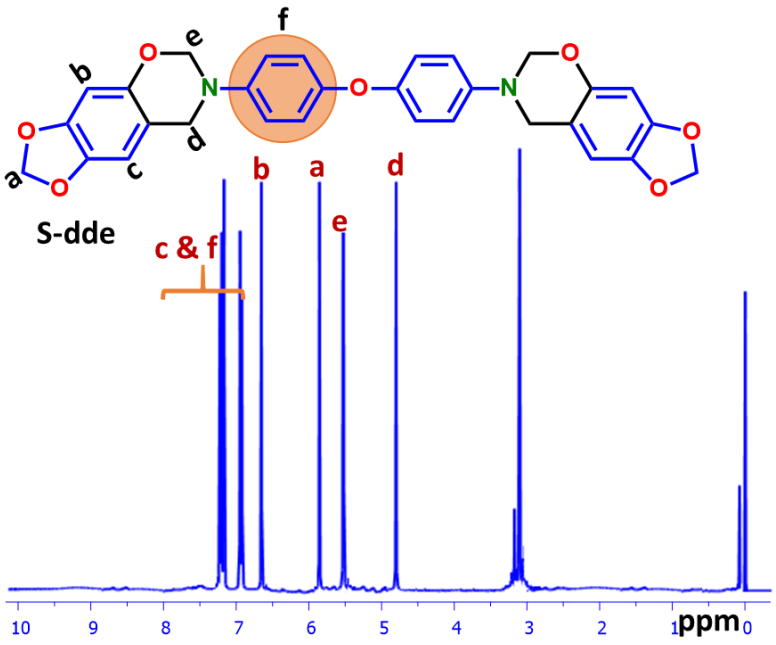

Fig. S17 ^{1}H-NMR spectrum of S-dde benzoxazine monomer

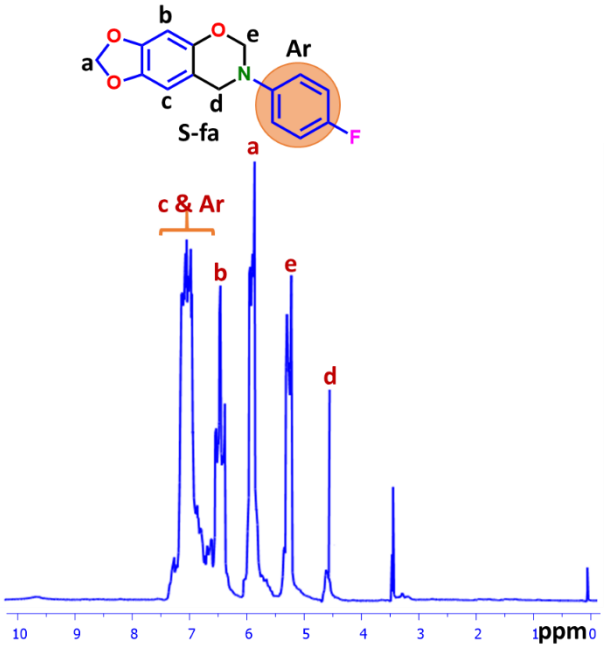

Fig. S18 ^{1}H-NMR spectrum of S-fa benzoxazine monomer

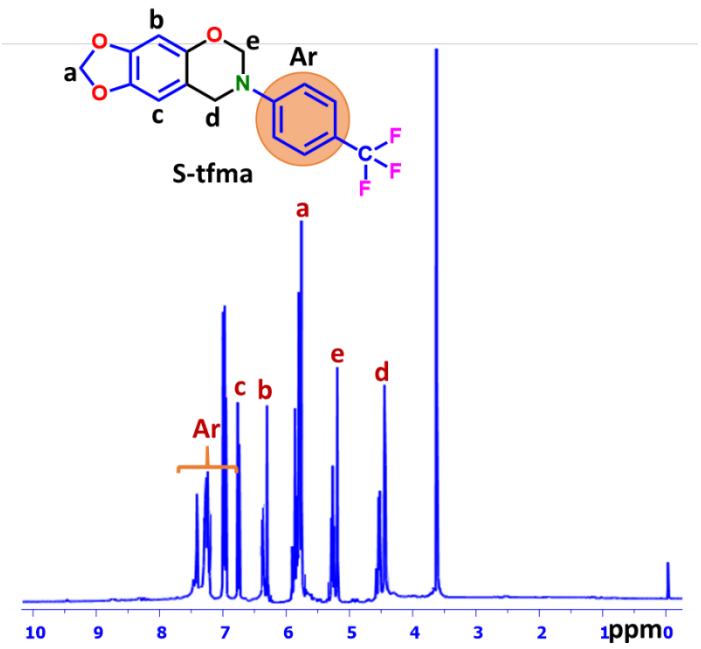

Fig. S19 ^{1}H-NMR spectrum of S-tfma benzoxazine monomer

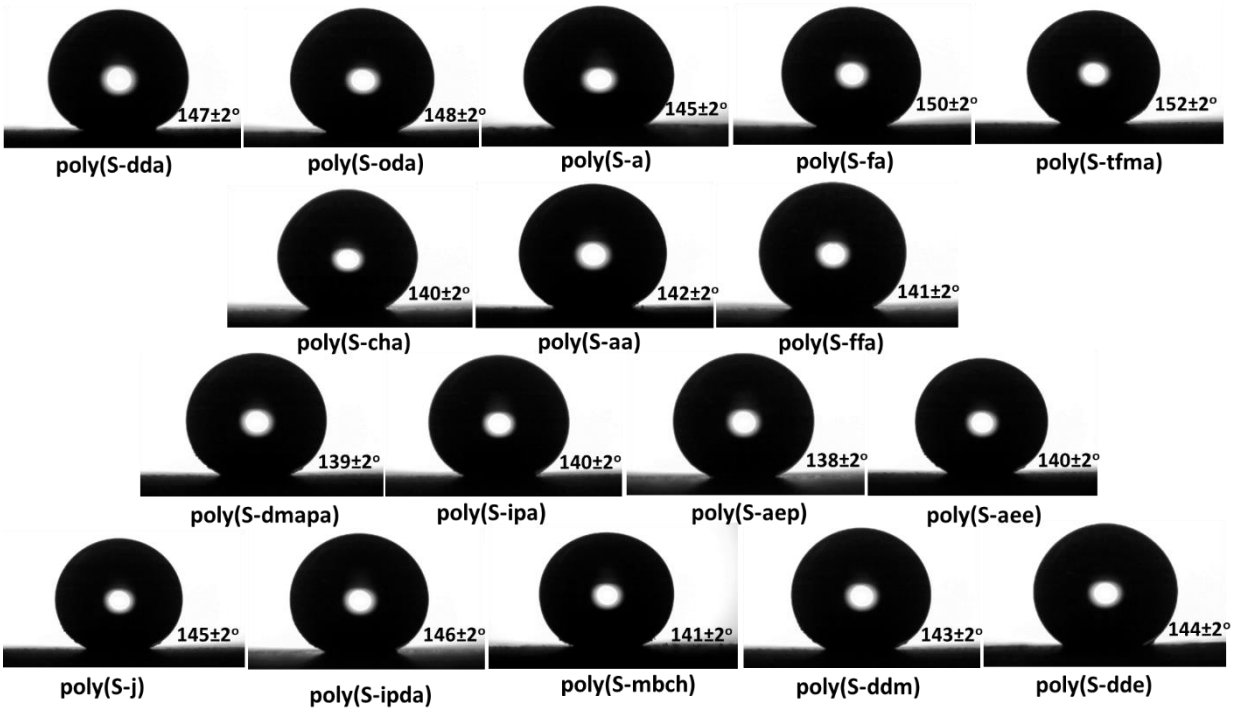

Fig. S20 Water contact angle images of sesamol based polybenzoxazines.

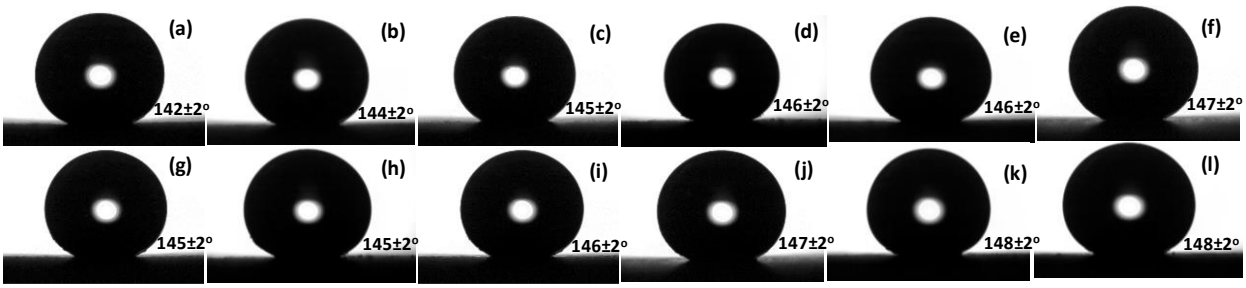

Fig. S21 Water contact angle images of sesamol based (a-f) bio-silica reinforced poly(S-ffa) and (g-l) GCN-c reinforced poly(S-dde) composites.

Fig. S22 Photographs of (a) neat cotton fabric, (b) benzoxazine coated cotton fabric and (c) cured cotton fabric