

In-situ sol-gel synthesis of silica reinforced polybenzoxazine hybrid materials with low surface free energy

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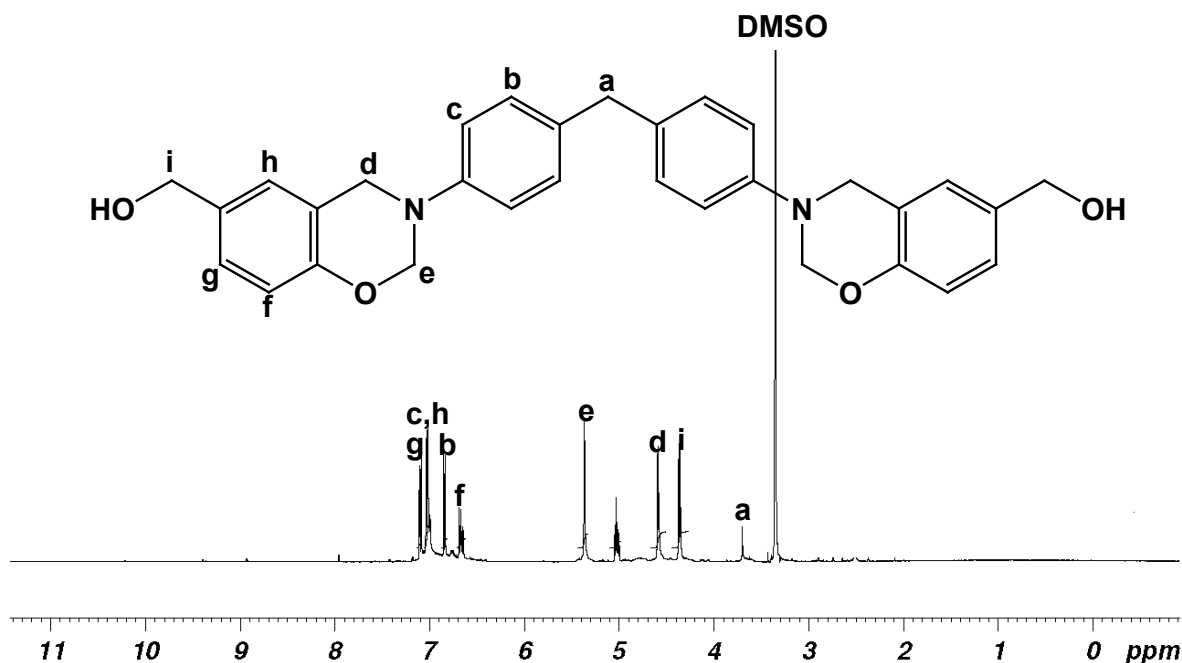


Figure S1 ¹H NMR spectrum of 4HBA-BZ

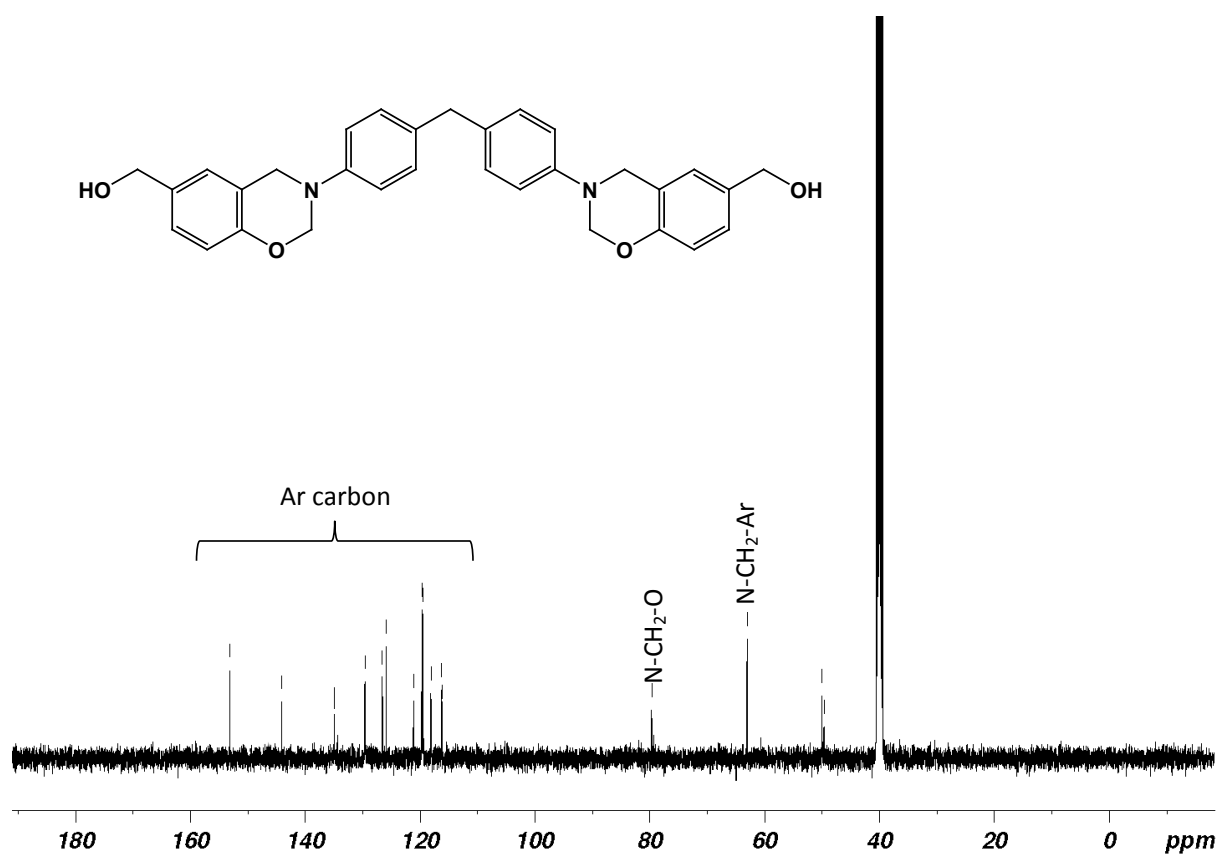


Figure S2 ^{13}C NMR spectrum of 4HBA-BZ

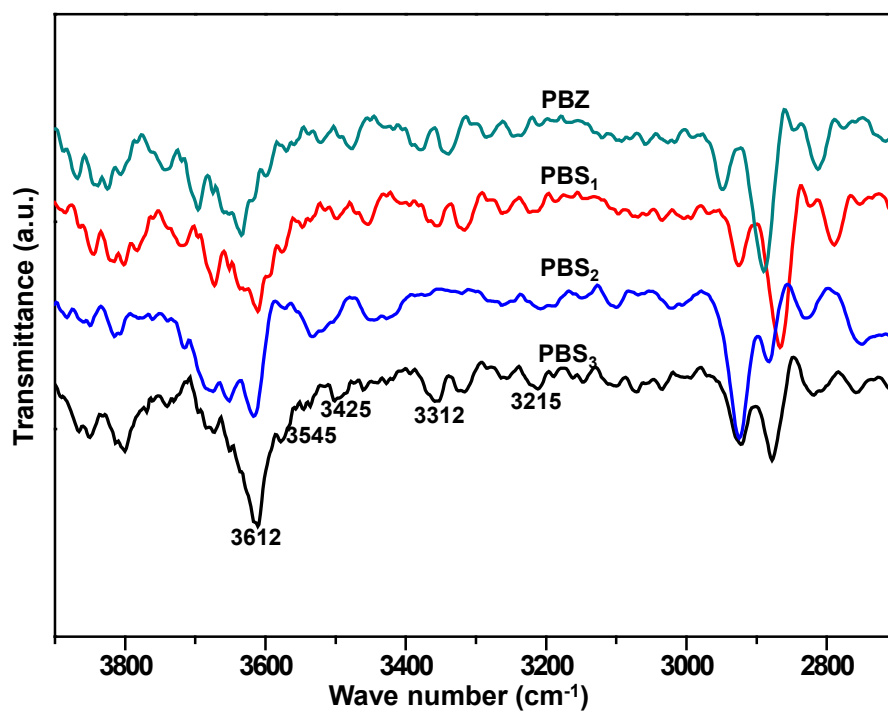


Figure S3: Expanded FTIR spectra for neat PBZ and PBS₁₋₃

Figure S3 shows the expanded FTIR spectra ($3900\text{--}2700\text{ cm}^{-1}$) of neat PBZ and PBS_{1-3} . From the figure, we observed different kinds of hydrogen bonds such as $\text{OH}\cdots\text{O}$ intermolecular hydrogen bonds at 3452 cm^{-1} , $\text{OH}\cdots\text{N}$ intramolecular hydrogen bonds at 3215 cm^{-1} , and $\text{O}\cdots\text{HN}$ intramolecular hydrogen bonds at 2785 cm^{-1} , free OH groups appeared at 3612 cm^{-1} , intramolecular $\text{OH}\cdots\pi$ hydrogen bonded peak presented at 3545 cm^{-1} , multiple intramolecular $\text{OH}\cdots\text{OH}$ hydrogen-bonded at 3313 cm^{-1} . It is clear that increase in intramolecular hydrogen bonding leads to a decrease in the surface free energy, These observations are in good agreement with the previous studies on surface free energy effects.

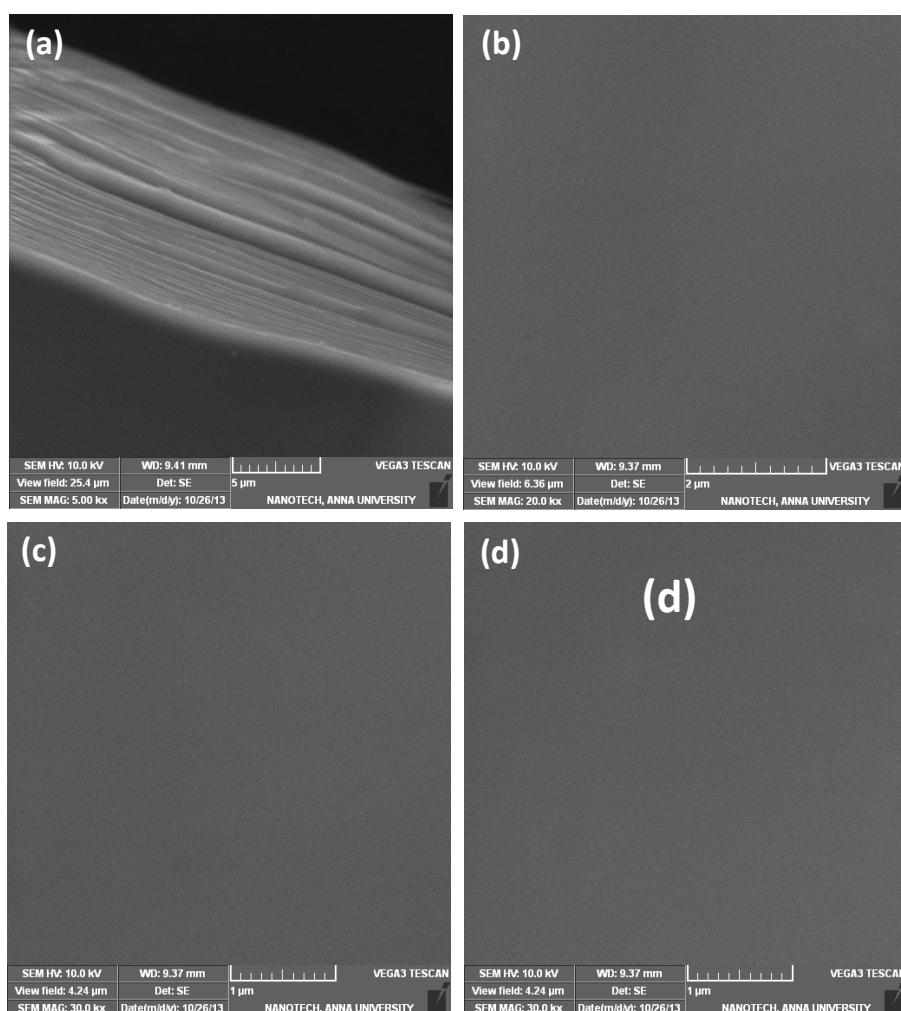


Figure S4 SEM images of (a) neat PBZ, (b) PBS1, (c) PBS2 and (d) PBS3 hybrid materials

Figure S4 shows the SEM micrographs of neat PBZ and PBZ-SiO₂ hybrid films. Figure S3a represents the SEM image of PBZ, from the image it can be observed that there is no crack, flaws and voids. Figure S4(b-d), represents the PBS₁₋₃, from the Figure it is observed that there is no significant inorganic domain size present in the developed nanohybrid films. The hybrid films showed good compatibility between the polymer matrix and the SiO₂ phase. The elemental composition of PBZ-SiO₂ hybrid material was analyzed using EDAX and are presented in Figure S5. From the Figure, the PBS₃ have higher silica content when compare to that of PBS₁₋₂.

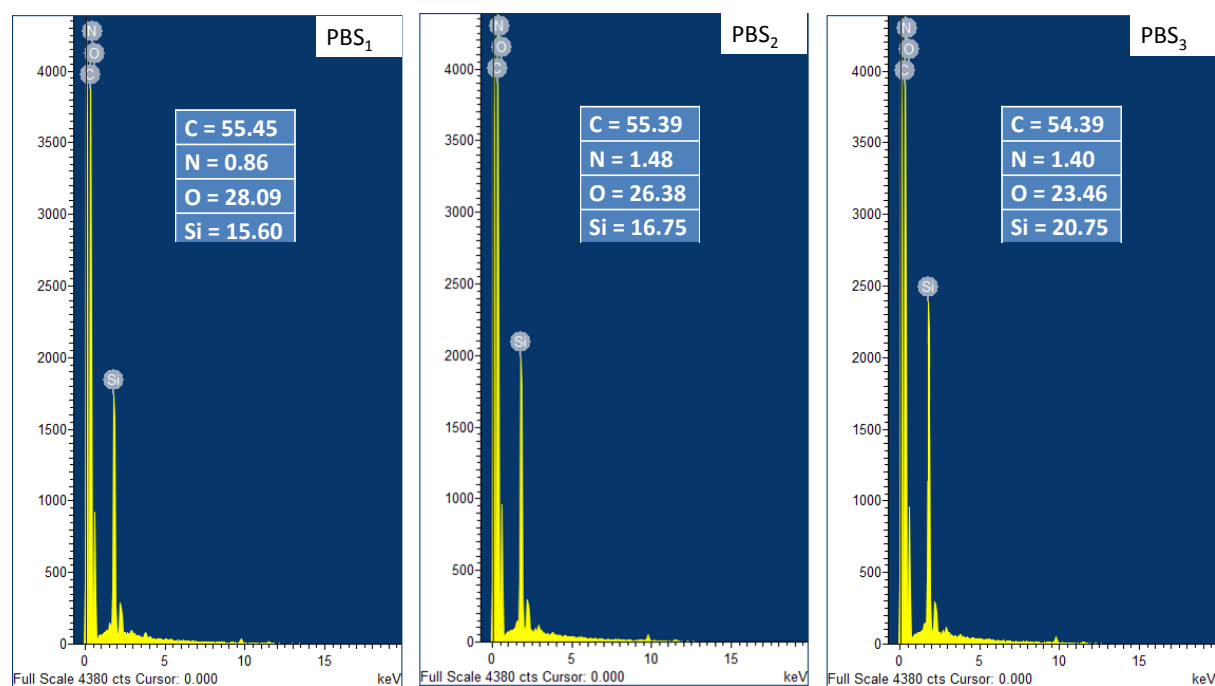


Figure S5: EDAX data for PBS₁₋₃