

## CONCLUSIONS

The bacterial cellulose (BC) sheets with electrical and magnetic properties can be readily fabricated based on polyaniline (PANI) and magnetite ( $\text{Fe}_3\text{O}_4$ ) particles via chemical oxidative polymerization and co-precipitation method in the presence of BC respectively. The BC was produced from *Acetobacter xylinum* TISTR 975. The morphology and chemical structure of the BC sheets containing PANI were investigated by SEM and FT-IR analysis. SEM micrographs revealed that PANI covered the surfaces of the BC fibers and the thickness of PANI deposition on BC nanofibrils increase with the amount of aniline monomer (AN), which was . And also, the completeness of the coating  $\text{Fe}_3\text{O}_4$  and PANI on the surface of BC sheets can be seen from SEM micrographs. Characteristic peaks of both the BC and PANI were observed in the FT-IR spectra of the BC sheets containing PANI. The thermal stability of the BC sheets with and without PANI were studied by thermo gravimetric dynamic temperature analysis (TG-DTA) and it was found that the thermal stability of the BC sheets with PANI was increased as compared to that of the pure BC sheet. In addition, thermal stability of the BC sheets with and without  $\text{Fe}_3\text{O}_4$  was investigated and revealed that the incorporating of  $\text{Fe}_3\text{O}_4$  can significantly improve the thermal stability of BC sheet containing  $\text{Fe}_3\text{O}_4$ . The electrical conductivity of doped BC containing PANI increases from 2.29 to 6.17 S/cm with the increasing of used AN from 15 to 30%wt. The percolation threshold is observed when the used aniline monomer increases from 30% to 40%wt. Moreover, the effect of relative humidity on the electrical conductivity of the BC sheets with PANI was investigated. The electrical conductivity of the BC sheets with PANI increased from 2.02 to 7.06 S/cm with increasing the relative humidity from 11.3 to 75.3 %. BC containing  $\text{Fe}_3\text{O}_4$  did not have the electrical properties, whereas, BC containing both  $\text{Fe}_3\text{O}_4$  and PANI had the  $\sigma$  comparable with BC sheets containing only PANI. The saturated magnetization,  $M_s$  and coercivity,  $H_c$  of BC sheets containing  $\text{Fe}_3\text{O}_4$  with different in the initial concentration of iron precursors were determined by VSM technique and it was found that  $M_s$  of BC sheets containing  $\text{Fe}_3\text{O}_4$  increased from 3.14 to 18.38  $\text{emu g}^{-1}$  with increasing the initial concentration of iron precursors and all of samples showed very small hysteresis loops and had very low coercivity;  $H_c \approx 59.51\text{--}82.26$  Oe. The

bending deformation of BC film containing PANI under the electric field demonstrated that it has desirable properties in electric field. And finally, all of desirable properties including high electrical conductivity, very low coercive field, and fairly  $M_s$ , are ideal for application in electromagnetic shielding application.