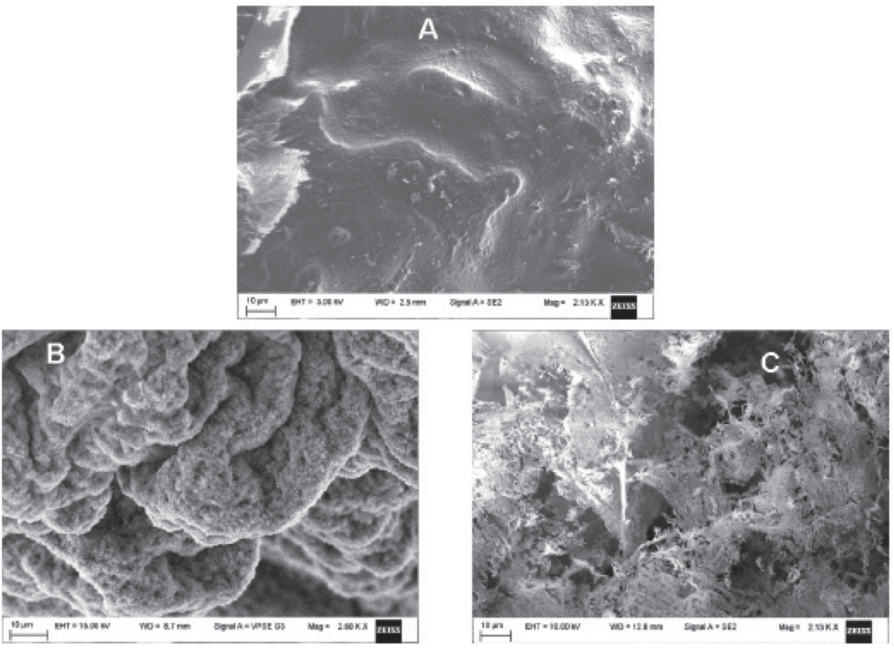

Fig. 20. FE-SEM images of (a) freeze-dried CMC-$CoFe_2O_4$ NP, (b) with application of SMF and (c) after AMF (Uva et al. 2014).

The SMF determines a lengthening and thinning of the $CoFe_2O_4$ NP hydrogel with the consequent reduction in the pore diameters, thus hindering the release of the drug (Fig. 21). In contrast, AMF determines the formation of fissures and pores, allowing an easier release of the drug. Unexpectedly but strictly consequential, a similar trend for the water uptake of the two hybrid $CoFe_2O_4$ NP hydrogels, measured under SMF and AMF, was observed. The water uptake of both the MNP hydrogels under AMF was in fact larger than in the absence of any magnetic field. The water uptake without the application of the magnetic field was, in turn, greater than the value obtained under SMF.

The MNPs in the CMC hydrogel exhibits a hysteretic behavior at room temperature, thus absorbing power from the AMF at any frequency and inducing torques on the NPs, which are transmitted to the polymer strands to which the NPs are covalently bound. This effect only occurs because the MNPs act as crosslinkers, i.e., as nodes of the polymeric network (Fig. 22). The torques induce a strong destruction of the hydrogel morphology. A different trend was observed with Fe_3O_4 NP hydrogel, where the influence of SMF is null and the line of DOXO release lays on that without any magnetic field (Fig. 23) (Uva et al. 2014). That behavior might be due to the partial strong aggregation of the nanoparticles in the hydrogel, as revealed by FESEM image, which does not allow any modification of the hydrogel material subjected to SMF.