greater than that released by the same CMC-MNP not exposed to magnetic stimuli. On the contrary by applying a static magnetic field (0.23 T or 0.48 T), the release of the MB is slowed down compared to that obtained without the application of any magnetic field. This system shows the ability to control an increase or a decrease in the release of methylene blue dye using the same hydrogel.

By a cyclic sequence of AMF and SMF applications, it is possible to achieve a modulation of the drug release. Figure 19 shows the release trend of methylene blue from CMC-NP 50 hydrogel under the application of SMF and AMF in sequence (Camponeschi et al. 2015). Furthermore hydrogels with magnetic (Fe_3O_4) NPs used as crosslinkers of polysaccharide chains were investigated for the release of the antitumor DOXO drug (Uva et al. 2015). Using an AMF can significantly enhance the drug release from the hydrogel. On the contrary, the application of a static magnetic field (0.5 T) does not affect the release properties of the CMC-NP (Fe_3O_4) hydrogel.

The release of any molecule from a magnetic hybrid hydrogel depends on the structural modifications occurring in the hydrogel as a consequence of the application of Static Magnetic Field (SMF) or Alternating Magnetic Field (AFM). Field Emission Scanning Electron Microscopy (FE-SEM) analysis of the hydrogels showed a more packed structure with some rough protuberances when a SMF was applied to the hydrogel in comparison to the smooth surface of the native hydrogel (Fig. 20). On the contrary the formation of several pores, cracks and unraveling on the hydrogel surface was observable after the application of AMF.

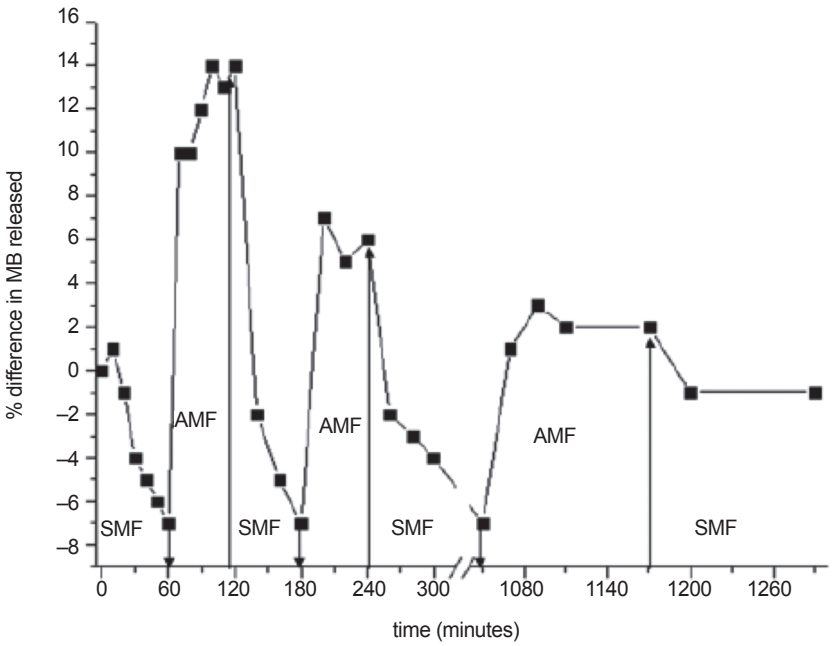

Fig. 19. Release curve of methylene blue from CMC-($CoFe_2O_4$) NP in 0.15 M NaCl under the SMF (0.5 T) and AMF (0.5 T, 4 Hz) applied in sequence (Camponeschi et al. 2015).