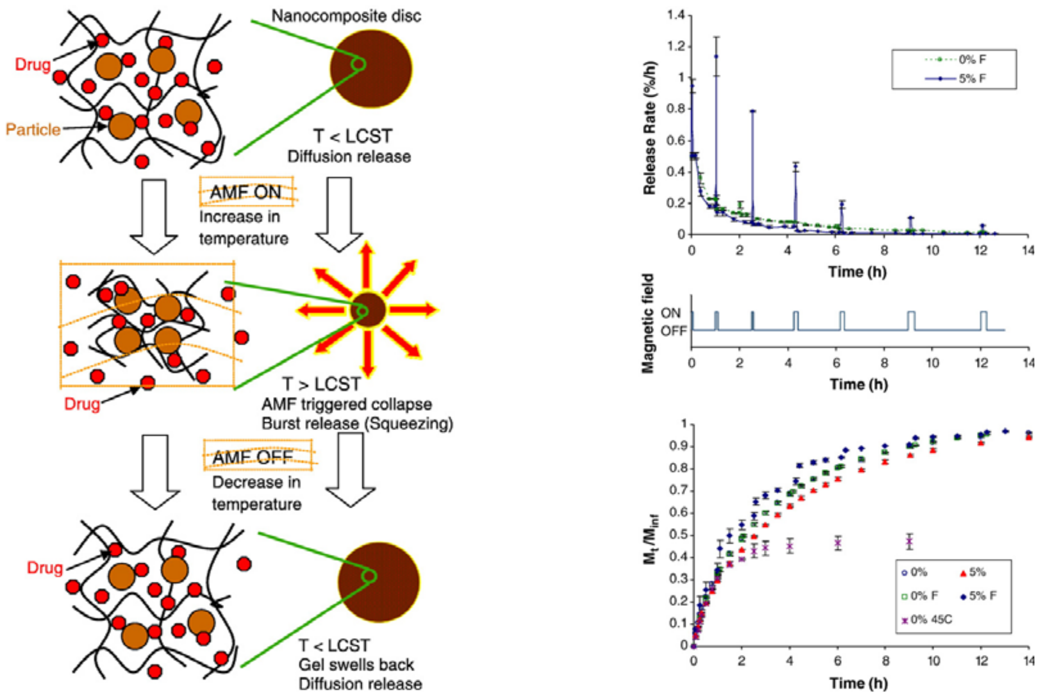
Hydrogels and hydrogel composites are currently being extensively studied for various high interest biomedical applications including drug delivery, tissue engineering, and microfluidic valves. The incorporation of nanoparticles into a hydrogel matrix can provide unique properties including remote actuation and also improve properties such as mechanical strength. In this poster, development and characterization of magnetic hydrogel nanocomposites, along with remote controlled (RC) demonstration of pulsatile drug delivery and soft actuator applications, will be highlighted.

Magnetic nanocomposites of temperature responsive poly (N-isopropylacrylamide) (PNIPAAm) hydrogels were developed by incorporation of superparamagnetic Fe_3O_4 nanoparticles. The nanocomposites show negative temperature sensitivity, and the temperature sensitivity and swelling transition temperature can be controlled by composition of PNIPAAm in the hydrogel system. When exposed to external alternating magnetic field (AMF), heating of superparamagnetic Fe_3O_4 particles led to rise in temperature of the nanocomposite system. The rise in temperature can be controlled by particle loadings of the system. Application of the nanocomposites as RC drug delivery systems is of high interest. A schematic of the proposed actuation and controlled delivery is illustrated in Figure 1 (a).

RC drug release was demonstrated from magnetic nanocomposites by application of alternating magnetic field. On application of field, the nanocomposite temperature increased above the LCST resulting into accelerated collapse. The collapse expelled large amounts of imbibed water, resulting in drug release at an increased rate. Magnetic nanocomposites can thus give pulsed release when needed in addition to continuous Fickian release profile. Figure 1(b) shows release profile of vitamin B_{12} to show effective modulation in release by pulse application of AMF.



(a) (b)

Fig. 1 (a) Schematic showing the effect of ON-OFF cycles of AMF to the magnetic nanocomposites of PNIPAAm. (b) Vitamin B_{12} release from magnetic nanocomposites of PNIPAAm on pulsed application of AMF. % represents particle loading by weight. F represents application of AMF. M_t represents cumulative mass released at time t. M_{inf} represents cumulative mass released over 48 h.

The rate of hydrogel collapse and recovery are key parameters in design of hydrogel as a component of drug delivery device. The goal of another study was characterization of magnetic PNIPAAm hydrogels with different film thickness. AMF was applied to gels of different thickness, resultant heating and triggered collapse was studied. Heat and mass transfer analysis was conducted to correlate the film thickness with kinetics of AMF triggered heating, collapse, and subsequent recovery.

Present studies are underway to incorporate the hydrogel nanocomposite as a valve in a ceramic microfluidic channel. Application of AMF can heat and collapse the gel, leading to opening of the valve. Thus, flow through the channel can be regulated remotely using AMF.