Supplementary Data

The purpose of this study is to preparing a carrier that has a simple structure and composition and with the multifunctional properties of microwave-targeted-fluorescence to precisely control the delivery of the drug. Herein, we use the $ZnAl_2O_4:Eu^{3+}$ as an important material of the carrier which not only possesses microwave thermal conversion property but also having the characteristic of fluorescent luminescence. The important characterization about $ZnAl_2O_4:Eu^{3+}$ are shown in the manuscript. And some similar characterization and interpretation with others are shown in the supporting information.[1-2]

Structure and Magnetic Properties of samples.

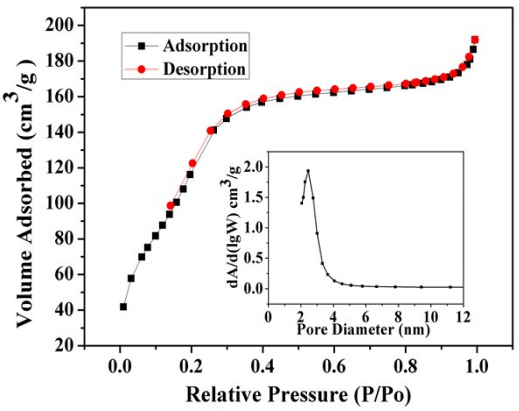

Fig. S1 N_2 adsorption/desorption isotherms of FZAM-APTES. The inset shows the pore size distribution curve obtained from the adsorption data.

The liquid nitrogen adsorption/desorption isotherms of FZAM-APTES are shown in Fig. S1. The curve i s the typical Ⅳ isothermal curve with H1 hysteresis loop, which is due to the presence of capillary agglomeration in the pores with relatively uniform pore size. The results shown that the FZAM-APTES drug-carrier has a high BET surface area and total pore volume of 518.60 cm^2/g and 0.275 cm^3/g, respectively. The inset in Fig. S1 is the pore size distribution of the carrier which shows that our carriers have an average pore size of 2.43 nm with the uniform pore size distribution. The result revealed that the mesoporous silica layer has been coated on the surface of outer FZA using CTAB as template and formed the pore structure.[3]

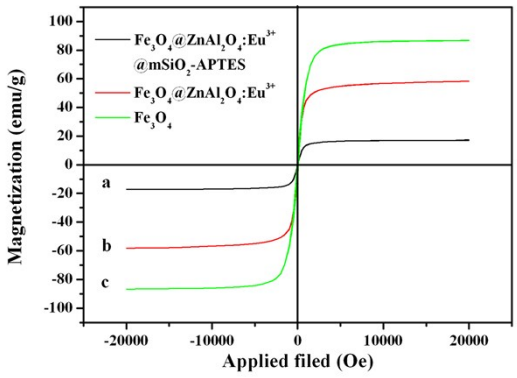

Fig. S2 Magnetic hysteresis loops of Fe_3O_4 (a), FZA (b) and FAZM-APTES-VP16 (c).

Magnetic measurement (Fig. S2) showed that Fe_3O_4, FZA and FZAM–APTES –VP16 microspheres have magnetization saturation (M_s) values of 86.8, 58.4 and 17.4 emu/g, respectively. The reduction in M_s value could be attributed to the lower density of the magnetic component in the FZAM–APTES–VP16 samples because the presence of $ZnAl_2O_4:Eu^{3+}$, $mSiO_2$, APTES and VP16 dilutes the concentration of

Fe_3O_4 nanoparticles. It should be noted that the VP16-loaded sample still shows high magnetization, which will have a potential application for targeting and separation.[4]

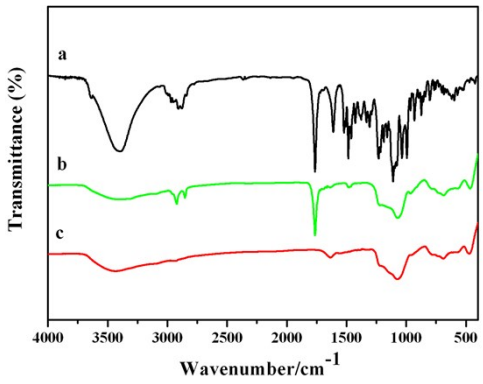

Fig. S3 FT-IR spectra of VP16 (a), FAZM-APTES-VP16 (b) and FZAM-APTES (c).

The FT-IR spectra of VP16, FZAM-APTES and FZAM-APTES–VP16 are given in Fig. S3. In the FT-IR spectrum of FZAM-APTES (Fig. S3c), an obvious peak at 1630 cm^{-1} is the characteristic absorption peak originated from the symmetrical $–NH_3^+$ bending. A weak peak at 2925 cm^{-1} is the characteristic absorption peak of $–CH_2–$, this is because the silanol on the surface of mesoporous SiO_2 and the triethoxy of APTES had a reaction to form $–Si–O–Si–CH_2CH_2CH_2–NH_2$ which further verified the aminopropyl of APTES has connected to the silica shell, so that the mesoporous silica and APTES were connected by covalent bonds.[5] As shown in Fig. S3a and b, in the infrared spectrum of VP16 and FZAM–APTES–VP16, the absorption peak at 1481 cm^{-1} is the characteristic vibration peak of C=C of the aromatic skeleton. The IR absorption peak at 1763 cm^{-1} is the characteristic peak of the stretching vibration of

C=O. In addition, other VP16 absorption bands at 1227 and 1109 cm^{-1} also appear in the IR spectrum of FZAM-APTES-VP16, which are the vibration absorption peak of C−H. This further confirms VP16 has been successfully linked to the pores of the mesoporous SiO_2 shell of FZAM-APTES nanoparticles. In Fig. S3b and c, the absorption bands at 566 and 680 cm^{-1} were assigned to $ZnAl_2O_4$ particles of the regular spinel structure. [6]

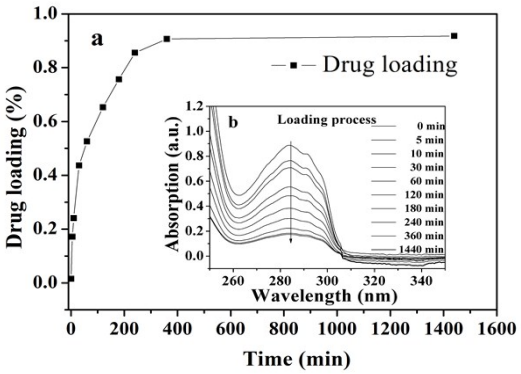

Fig. S4 Drug loading analysis with different time intervals: drug loading as a function of time.

To study the drug storage and release properties of this system VP16 was selected as a model drug. To eliminate the influence of other factors, drug loading and release experiments were performed in sodium chloride solution (0.9% w/v, similar to the normal saline of the human blood system) and at the temperature of 37 °C. The temperature of 37 °C was selected because it is close to physiological temperature. The mesoporous shell provides a large accessible pore volume for the adsorption of drug molecules, and the average pore size of FZAM-A was 2.43 nm, which is larger than the molecular length of VP16 (≈1.34 nm). VP16 was absorbed onto the surface

of the samples with silanol groups and a mesoporous silica layer, and VP16 molecules have been absorbed on the silica surface of the mesoporous layer and released via a diffusion-controlled mechanism and microwave control.

References

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