A Novel Strategy to Directly Fabricate Flexible Hollow Nanofibers with Tunable Luminescence-Electricity-Magnetism Trifunctionality Using One-Pot Electrospinning

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Supplementary Information

Infrared spectra analysis

In order to better illustrate, we also performed the Fourier-transform infrared (FT-IR) test for PVP, Eu(BA)$_3$phen complex, Eu(BA)$_3$phen/PVP hollow nanofibers and Eu(BA)$_3$phen/PANi/Fe$_3$O$_4$/PVP hollow nanofibers, as presented in Fig. S1. A predominant peak at 1650 cm$^{-1}$ is attributed to the C=O groups in PVP (Fig. S1a), and the peaks at 1444 and 1294 cm$^{-1}$ correspond to the bending vibration of –CH and the stretching vibration of –CN, respectively. The broad band centered at 3420 cm$^{-1}$ ($\nu$(O-H)) is attributed to coordinated waters, and the broad band located at 2960 cm$^{-1}$ is assigned to C–H stretching vibration. Fig. S1b shows the FT-IR spectrum of Eu(BA)$_3$phen complex. The peaks at 1608 cm$^{-1}$ and 1396 cm$^{-1}$ can be assigned to the antisymmetric and symmetric stretching vibration of COO$^-$. One sharp peak is observed at 1517 cm$^{-1}$, which is attributed to C=N group in Eu(BA)$_3$phen complex. It is also observed that Eu$^{3+}$-O$^2-$ stretching vibration peaks locate at 430 cm$^{-1}$. The FT-IR spectrum of Eu(BA)$_3$phen/PVP hollow nanofibers is similar to that of pure PVP. The reason is that Eu(BA)$_3$phen complex is doped in PVP matrix. Through careful analysis, one can find that Fig. S1c is not the simple mixture of Fig. S1a and Fig. S1b, and the peak at 1662 cm$^{-1}$ shifts from 1650 cm$^{-1}$, which may be due to complexing interaction between Eu$^{3+}$ ions of Eu(BA)$_3$phen complex and C=O groups of PVP.\(^2\) The FT-IR spectrum of Eu(BA)$_3$phen/PANI/Fe$_3$O$_4$/PVP hollow nanofibers is shown in Fig. S1d. Peaks at 3200–3000 cm$^{-1}$ and 3000–2800 cm$^{-1}$ correspond to –N–H and –C–H stretching vibrations of polyaniline. Absorption peak at 1434 cm$^{-1}$ is assigned to C=C stretching of benzenoid rings of emeraldine form of polyaniline. The characteristic bands at 1303 and 1145 cm$^{-1}$ represent the C–N stretching of benzenoid structure and in-plane C–H bending of quinoid structure, respectively.\(^3\) The band at 580 cm$^{-1}$ corresponds to the vibration of the Fe–O bonds in the crystalline lattice of Fe$_3$O$_4$.\(^4\) The above results indicate that PANI has been synthesized, and Fe$_3$O$_4$ nanoparticles have been successfully added into the hollow nanofibers.

Fig. S1 FT-IR spectra of PVP (a), Eu(BA)$_3$phen complex (b), Eu(BA)$_3$phen/PVP hollow nanofibers (c) and Eu(BA)$_3$phen/PANI/Fe$_3$O$_4$/PVP hollow nanofibers (d).

References