The interest to innovative products with high added values and processes in textile field has been rapidly increasing among the other industrial fields. One of innovations in this field is to produce of innovative textiles containing phase change material (PCMs) that have thermal storage and thermo-regulation properties. This study deals with preparation and characterization of poly(methylmethacrylate-co-glycidyl methacrylate)/n-hexadecane nanocapsules containing n-hexadecane as phase change material for thermal energy storage. The chemical characterization of poly(methylmethacrylate-co-glycidyl methacrylate)/n-hexadecane nanocapsules was made by fourier transform infrared (FT-IR) spectroscopy method as particle size and its distribution (PSD) were studied by scanning electron microscopy (SEM). Thermal properties of nanoencapsulated n-hexadecane were determined using differential scanning calorimetry (DSC). The melting and freezing temperatures of the nanoencapsulated n-hexadecane were 17.23 and 14.85°C respectively as the latent heats of melting and crystallization were 148.05 and −147.63 J/g respectively. Produced nanocapsules were applied to polyacrylonitrile (PAN) by means of electrospinning and surface morphology of the fibers was investigated by SEM analysis. Based on the results, it can be considered that the nanoencapsulated n-hexadecane in poly(methylmethacrylate-co-glycidyl methacrylate) have good energy storage potential to be used in fibers.