Size dependent transition temperature of polymer nano-wires fabricated by two-photon polymerization

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By the use of two-photon polymerization (TPP) method, we fabricated polymer nano-spring composed of cross-linked polymethylmethacrylate spiral wire with hundreds of nanometers radius (Figure1) [1,2]. In this nano-spring, we observed change of transition temperature by the size of polymer nano-wire. We measured transition temperature of the polymer nano-wire by measuring shear modulus of the nano-spring. We stretched the nano-spring in solution by means of laser trapping and measured the maximum stretch length. We controlled temperature of the nano-spring by a heating/cooling device attached on a microscope. Transition temperature brings considerable change in mechanical property of polymer. Indeed we observed transition temperature at 20~40°C from the considerable change of maximum stretch length (Figure2). We measured the transition temperature for various nano-springs with different radius of nano-wires. The transition temperature decreased more than 40 K by decreasing the radius of nano-wire from 450 nm to 150 nm (Figure3). This result indicates that transition temperature depends on the size of polymer nano-wire. Similar size dependent transition temperature has been reported in thin film of polymer[3]. In this study, we suggests a new method for the measurement of transition temperature in nano-sized polymer using laser trapping technique.