Abstract

Stimulus-responsive polymers, also called intelligent materials, have an array of characteristics that vary in response to external stimuli such as temperature, light, pH, and electricity. Recently, research has been actively carried out in this area, and stimulus-responsive polymers that vary their characteristics according to temperature have attracted considerable interest in many fields including medicine and biotechnology.

Further, the thermoresponsive gel obtained by three-dimensional cross-linking of the thermoresponsive polymer undergoes large changes in volume via reversible swelling and shrinking in response to changes in temperature. If a thermoresponsive gel can be microfabricated, the use of thermoresponsive gel characteristics such as reversible volumetric change and material delivery control will be enabled in various microdevices. In particular, the development of cell chips on which operations and reactions can be detected at a single-cell level has become required in structural and functional analyses of cells in recent years. Microfabricated thermoresponsive gel are expected to be applied as micropumps, valves, and tweezers on biochips that handle microscopic bodies such as cells.

In this research, thermoresponsive gel that can be directly microfabricated by photolithography and thermal nano-imprint were developed. This facilitated the straightforward application of the thermoresponsive gel as a material in various microchips and component parts. And this thermoresponsive gel that could be microfabricated was put to practical use in a cell chip that captured and released individual cells. This chip technology should prove useful in manipulating, analyzing, and systematically arranging various cells individually. This technology is anticipated to be applied in research to evaluate and analyze cellular functions such as metabolism and immunoresponse at a single-cell level.

Moreover, commercialized cooling sheets and skin care sheets have problems such as the cooling effect being weak, the duration of the effect being short, and the percutaneous absorption quantity of the moisturizing ingredient being small. Accordingly, in order to overcome these problems, research was carried out on a high-performance gel sheet in which a mechanically micronized thermoresponsive gel is disbursed throughout a traditional aqueous sheet. This high-performance gel sheet utilizes a function whereby microparticles of thermoresponsive gel, when heated by the skin, discharge a large quantity of absorbed water into their environment. As a result, the moisture supplied to the skin surface is increased and the cooling by evaporation of moisture is promoted. Thus, the cooling and moisturizing effects are enhanced in comparison with existing gel sheet agents. Cooling sheets and skin care sheets are now becoming mainstays in the field of skin care, and market growth is anticipated both in Japan and overseas. The “highly effective cooling sheet” and “highly moisturizing skin care sheet” developed in this research are expected to be used as high value-added sheet agents.