博 士 論 文 の 内 容 の 要 旨

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論文題目	Study on eco-friendly and energy-efficient treatments of nanofibers for advanced textile applications (環境にやさしいかつ優れたエネルギー効率を持つ先端テキスタイル用ナノファイバーに関する研究)

(博士論文の内容の要旨)

Conventionally, Textile processes consume a high amount energy and release bulk waste effluent to the environment. Sustainable growth of chemical processes is in urge to address serious environmental issues by the development of eco-friendly and energy-efficient processes, which may simultaneously be advantageous to the industries.

Our first project states the improvement in aesthetic properties of nanofibers next to functional properties, which has remained a challenging issue because of higher surface area of nanofibers.

Thus, we reported a successful ultrasonic-assisted dyeing of cellulose nanofiber and silk fibroin nanofibers with a deep comparison to conventional dyeing techniques, where ultrasonic-assisted dyeing showed a better color yield and improved color fastness properties over conventional dyeing for both each nanofiber-based cellulose and silk textile substrate.

The reason behind improved coloration properties was ultrasonication which help in rapid aggregation of dye molecules compared to conventional dyeing. Ultrasonic energy produces cavitation and increase intramolecular collisions within the dye molecules which plays an important role to enhance the efficiency of dyeing process and assist to achieve very good color yield properties.

At lower temperature a uniform dye transfer and even coloration can be achieved by continuous cavitation which ultimately result in less effluent discharge to the environment.

After achieving color yield properties on nanofibers, we attempted to improve color fastness properties of cellulose nanofibers, by using vat dyes, which are famous for attaining very good color fastness properties on conventional textiles.

Utilization of vat dyes on cellulose nanofibers revealed excellent color fastness properties with almost no color bleeding during washing off process, color fastness properties for dyeing keeps environment eco-friendly.

Dope-dyeing of polyurethane and polystyrene with indole-based photochromic dye have been reported with different dye concentrations, change in chemical/physical properties and stimuli-sensibility to ultraviolet and halogen light (temperature).

Additionally, photochromic nanofibers also mimic like a sensor that can be used for security of food/drug during transportation.

After achieving energy-efficient and environment friendly coloration of advanced textile materials, we attempted to develop an eco-friendly process to prepare nanofibers.

In our research, we focused to reduce the textile waste effluent by means of adsorption on novel super-hydrophilic Zein nanofibers.

Zein has attracted a great deal of attention due to its biocompatibility, biodegradability, non-toxicity and its wide abundance on earth. Electrospinning of Zein has yet been challenged by the limitation of reusability of the polymer solution and frequent clogging of spinneret when its dissolution occurs in aqueous-ethanol or its preparation using hazardous solvents, such as dimethyl formamide.

Recently deep eutectic solvents (DES) are widely recognized as non-volatile and non-hazardous solvents. Therefore, we prepared Zein nanofibers using DES for the first time, thanks to the cedar leaf morphology and the abundant presence of -NH and -OH groups on the surface of Zein nanofibers, which allow it to be used for the applications, where super hydrophilicity is required such as biosensors, drug release and adsorption of dyes/heavy metals.

The proposed method of preparing Zein nanofibers using DES opens a new door to continuous electrospinning with tunable morphology, having potential to be used for environmental, biomedical and advanced textile applications.

All chapters separately discuss necessary characterizations with a relation to chemical and physical properties.