

The 12th Research Grant Application in 2026
International Polyurethane Technology Foundation

/ / 2026

To: International Polyurethane Technology Foundation

Recommender

Name: _____ (Sign or Seal) _____
Organization/ Job Title: _____
Address: _____
Tel: _____ FAX: _____
E-mail: _____

I hereby attest that the applicant satisfies the eligibility criteria for your research grant and respectfully recommend this application.

◆ Research Grant Category * Please circle desired Research Grant either one.

1. **General research grant**

1 million JP yen per research project, 4 (four) research to be selected

2. **Research grants to encourage overseas researchers**

500 thousand JP yen per research project, 4 (four) research to be selected

◆ Representative researcher

Name: _____

Date of Birth (Year, Month, Day): _____

Organization/faculty/department: _____

Applicant job title: _____

Organization address: _____

TEL: _____ FAX: _____

Email address: _____

◆Major collaborates researchers

Name	Organization, Department and Researcher job title	Address

◆Research Title

In Japanese (if available)

クエン酸変性セルロースを用いる高性能生分解性ポリウレタン複合材料の開発

In English

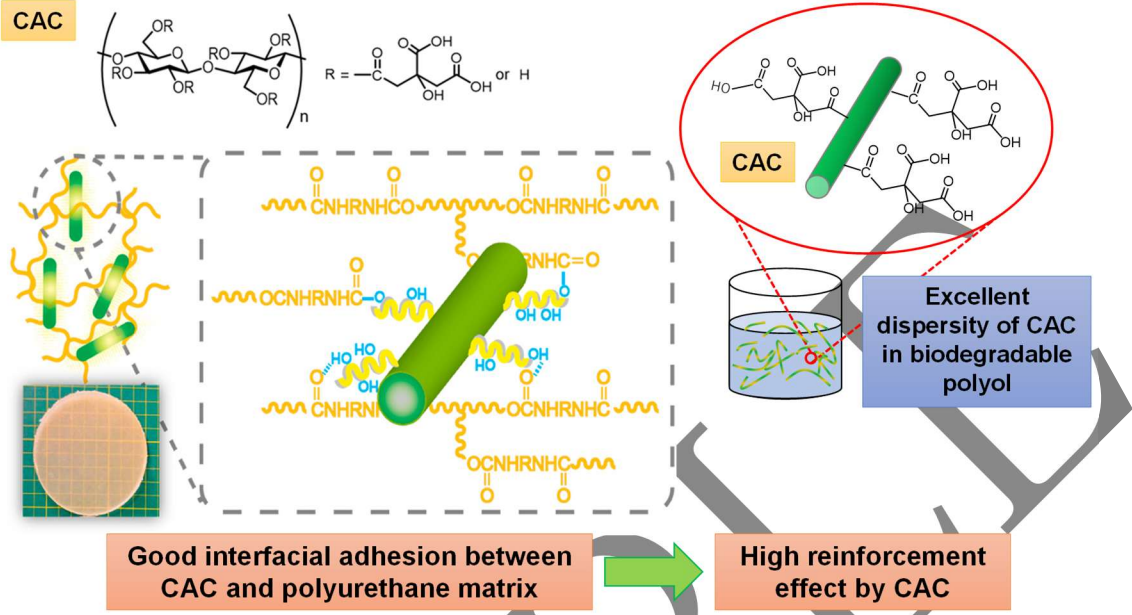
Development of high-performance biodegradable polyurethane composites using citrate modified cellulose

◆Abstract (Please fill the research abstract within 25 rows. If the row limit were exceeded, the application would not be selected.)

Environmentally friendly high-performance polyurethane prepared by utilizing citric acid-modified cellulose (CAC) well dispersed in biodegradable polyol. Good interfacial adhesion between CAC and polyurethane matrix shows high reinforcement effect by CAC.

◆ Abstract (Please post the Graphic Abstract in this frame)

Environmentally Friendly High-performance Polyurethane
prepared by utilizing citric acid-modified cellulose (CAC) well dispersed in biodegradable polyol



SAMPLE

◆ **Research objectives** (Please fill one page of the background, objectives, and target. If the limit of page were exceeded, the application will not be selected.)

The plastics industry has played a central role in the chemical industry, supporting the packaging industry and other manufacturing industries and contributing significantly to the development of the Japanese economy. On the other hand, **many plastics do not biodegrade in the natural environment**, which is a major social issue of concern, including global warming and the depletion of oil resources. **Cellulose and its derivatives have attracted significant attention because they are renewable, environmentally friendly, naturally abundant, biodegradable, and have excellent mechanical properties.** Furthermore, their structure is composed of numerous β -glucoses polymerized on a linear chain by glycosidic bonds, and they are highly crystalline due to intermolecular hydrogen bonds, resulting in high strength. These characteristics are expected to be utilized as fillers for polymeric materials.

PU is a multi-block copolymer composed of polyol oligomers and diisocyanate, and the combination of polyol and diisocyanate determines various mechanical properties. Therefore, PU is widely used in many fields such as foams, elastomers, coatings, and adhesives. Most of the PUs currently available on the market are derived from non-renewable petroleum resources and are non-biodegradable. However, with the growing awareness of environmental protection in recent years, **there is a strong demand for the use of sustainable materials and biodegradability for PUs.** However, the recent increase in awareness of environmental protection has led to a strong demand for the use of sustainable materials and biodegradability in PU. In this study, we aim to **develop an environmentally friendly high-performance PU by using cellulose, a typical biomass resource, as a filler to reinforce polyurethane with biodegradable polyols.** Cellulose is generally poorly dispersible in PU, and could not be applied to foam molding applications such as heat insulators and sponges. On the other hand, we have found that secondary modified cellulose based on **citrate-modified cellulose (CAC, Fig. 1)** disperses well in poly(propylene glycol) and is useful for improving PU performance (Fig. 2) [1]

The modified cellulose acts as a reactive filler and forms **a good interfacial adhesion between CAC and the PU matrix**, which can make the composite material stronger. In this study, we

utilize this knowledge to create high-performance biodegradable PU by selecting polyester polyols (poly(ϵ -caprolactone) (PCL) and poly(butylene adipate) (PBA)) to impart biodegradability to PU and developing cellulose fillers that are highly dispersible in polyester polyols. The cellulose filler forms potential physical and chemical cross-linking points in the PU matrix, which is expected to improve the performance of biodegradable PU. We believe that this research is significant as basic research for the creation and social implementation of PUs that contribute to decarbonization and the construction of a recycling-oriented society.

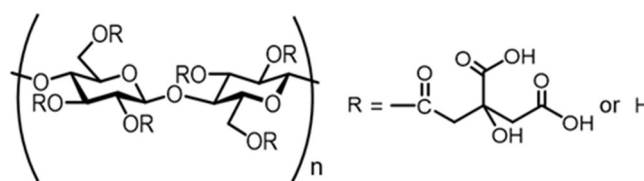


Fig. 1: Chemical structure of CAC

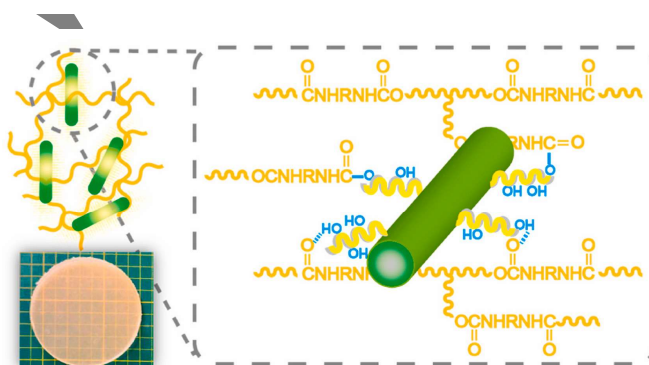


Fig. 2: Schematic of cross-linked structure by oligomers grafted from the surface of cellulose fibers

◆ **Research Papers, etc.**

(Please list up to three of your most recent research papers or related works that are relevant to the proposed research theme. For each item, provide the journal name, year of publication, volume, pages, title, authors, the applicant's role, and the nature of the contribution to the research. And please underline the applicant's name.)

[1] X. Cui *et al.*, *Compos. Sci. Technol.*, **2024**, *202*, 108595

Title: Development of high-performance biodegradable polyurethane composites using citrate modified cellulose

The applicant served as Leader in this research project.

The main contribution of the applicant includes the synthesis and the analysis.

SAMPLE

◆ **Outline of the research plan** (Please fill in documents, figures, graphs, etc. within one page. If the limit of page were exceeded, the application would not be selected.)

In order to develop high performance biodegradable polyurethane composites, the **key is to form a good interfacial adhesion between cellulose and polyurethane matrix**. In this study, we investigate (1) the development of highly dispersed polyester polyol modified cellulose fillers and (2) the synthesis and characterization of biodegradable PU reinforced with cellulose fillers.

(1) Development of highly dispersed polyester polyol modified cellulose filler

We have already established a technology to control the amount of carboxylic acid on the surface of CAC and the cellulose diameter by understanding the material such as grinders (Fig. 3). We have also developed a secondary modified cellulose with a large number of highly reactive hydroxyl groups by grafting glycidol and other substances from the carboxylic acid on the CAC surface. In this study, we will utilize these findings to develop cellulose fillers dispersed in polyester polyols (PCL and PBA). The dispersibility in polyester polyol will be evaluated using the amount of citric acid introduced, fiber diameter, and, if necessary, glycidol grafting as parameters. Fiber diameter was reduced to 500 nm by grinder treatment (Fig. 4, CACNF), which is expected to improve dispersibility in polyol. These findings will be correlated with the results of study item (2) and fed back to filler development.

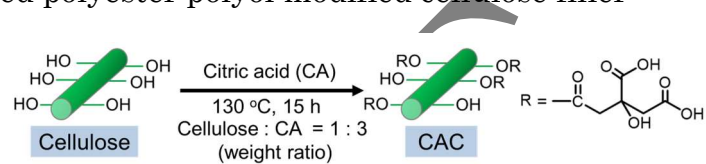


Fig. 3: Scheme for synthesis of CAC

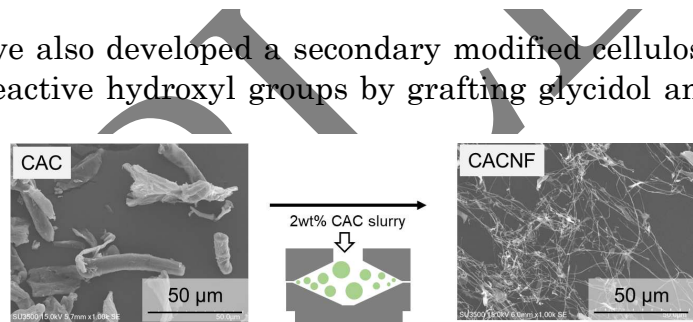


Fig. 4: Nanofiberization of CAC by micronization process

The dispersibility in polyester polyol will be evaluated using the amount of citric acid introduced, fiber diameter, and, if necessary, glycidol grafting as parameters. Fiber diameter was reduced to 500 nm by grinder treatment (Fig. 4, CACNF), which is expected to improve dispersibility in polyol. These findings will be correlated with the results of study item (2) and fed back to filler development.

Based on these observations, a material design that improves the interfacial affinity between the PU matrix and the cellulose filler will be established to create an interface with controllable physicochemical properties for the development of high-performance biodegradable polyurethane composites.