Customizable micropattern design of ZnO nanosheets on silk fibroin/gelatin films for biocompatible piezoelectric actuation

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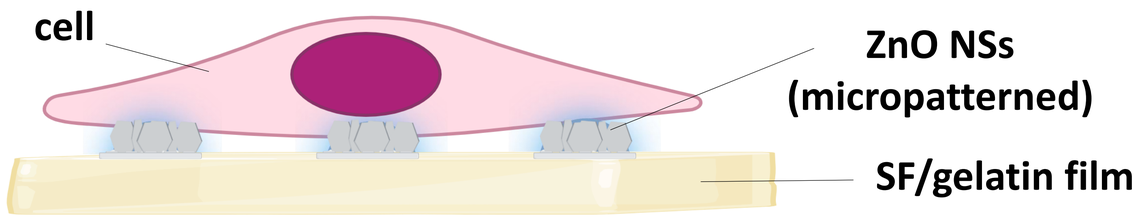
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INTRODUCTION:

The emerging demand for **flexible, biocompatible materials in wearable and implantable electronics** has accelerated research into organic–inorganic hybrid systems. Natural **piezopolymers**, such as **silk fibroin (SF) and collagen**, offer excellent biocompatibility and mechanical flexibility but exhibit **lower piezoelectric coefficients**. **Zinc oxide (ZnO)** has been shown to be **cytocompatible** when structured into in the form of **nanosheets (NSs)**, which are **capable of cell stimulation** and **can be selectively integrated onto different surfaces**. This work aims to integrate defined micropatterns of piezoelectric ZnO NSs onto SF/gelatin hydrogels via hydrothermal growth for later biomedical applications.

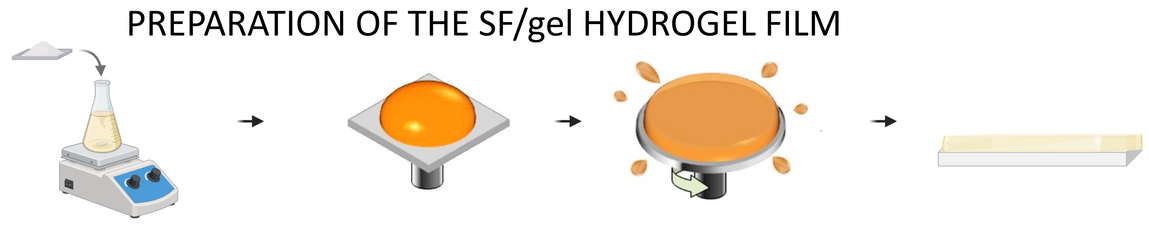
OBJECTIVE:

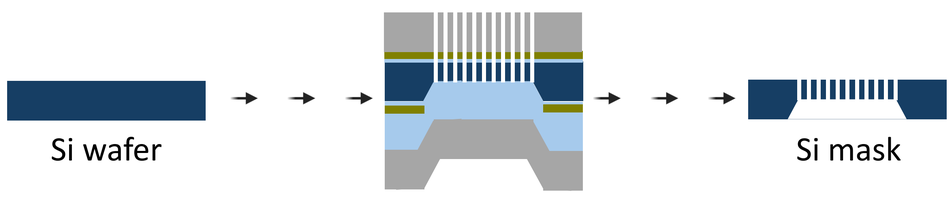
To develop a **ZnO/SF/gelatin hybrid system** that **combines mechanical flexibility, structural stability, and piezoelectric functionality** in an **easy-to-manufacture biocompatible** form for its later use as soft wearable bioelectronic interface for tissue engineering.



METHODS:

PREPARATION OF THE SF/gel HYDROGEL FILM

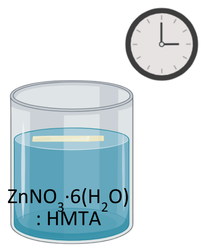




MICROFABRICATION PROCESS OF THE MICROPATTERNED MASK



Aluminum coating



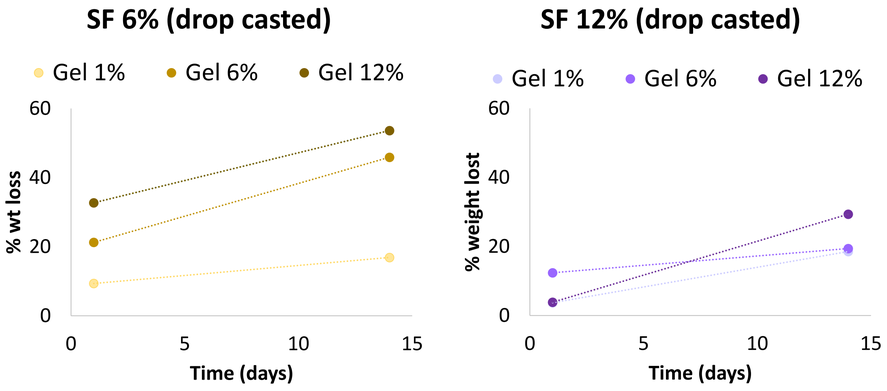
Hydrothermal growth of ZnO NSs

ZnO/SF/gelatin hybrid flexible piezoelectric film

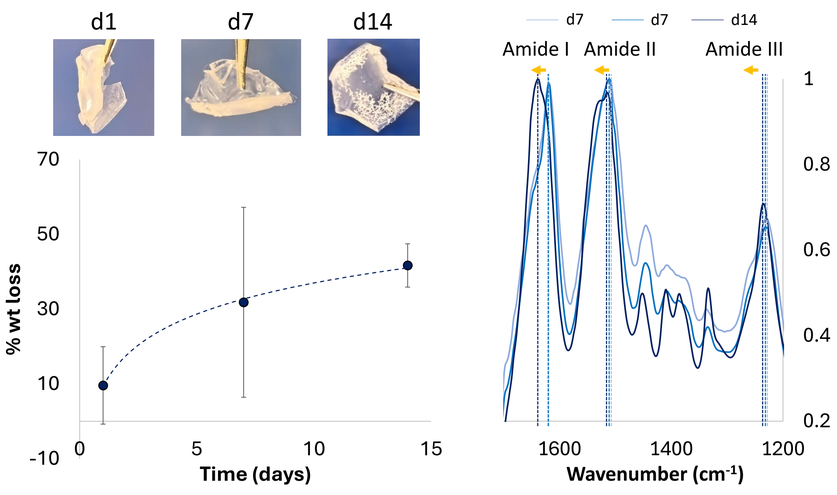
RESULTS:

SF/gel degradation assays

Degradation of SF/gel at different percentages

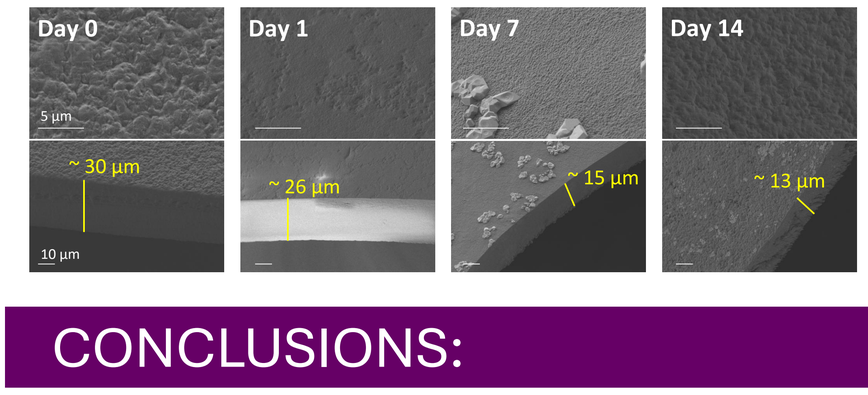


Degradation of SF12%/gel1% spin coated films



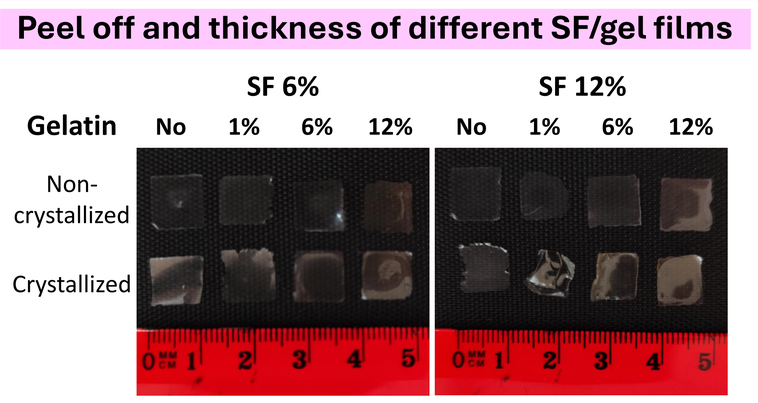
Day	1	7	14
% wt loss	9.6 ± 10.4	31.8 ± 25.4	41.7 ± 5.8

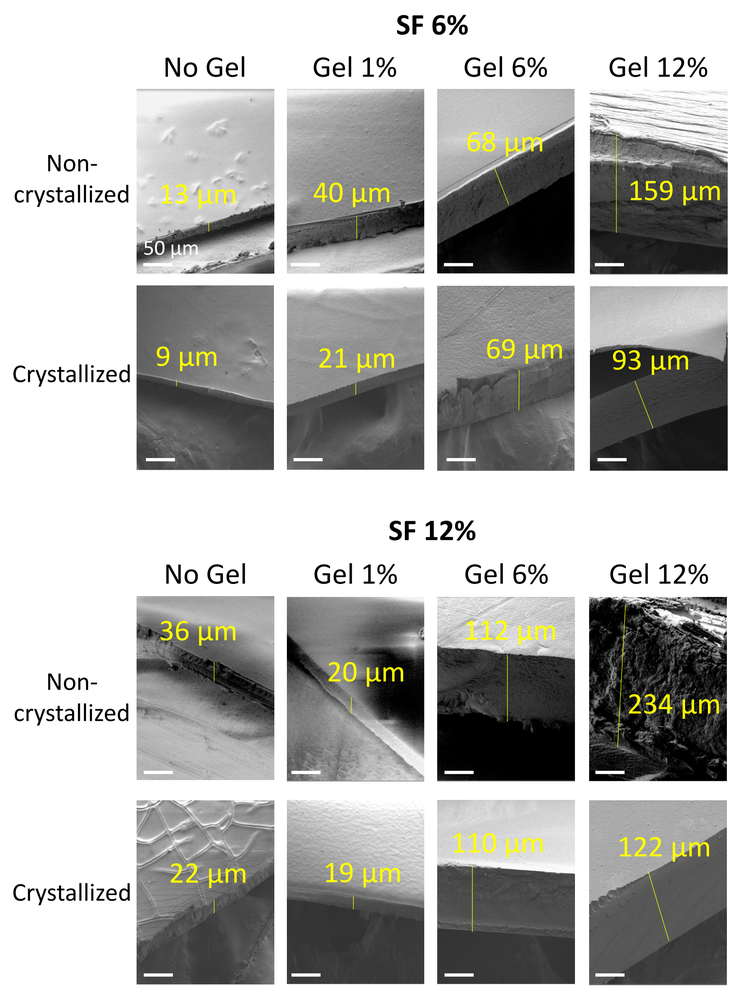
Amide I	Amide II	Amide III
1637 cm^{-1}	1514 cm^{-1}	1235 cm^{-1}
1619 cm^{-1}	1510 cm^{-1}	1231 cm^{-1}
1619 cm^{-1}	1508 cm^{-1}	1229 cm^{-1}



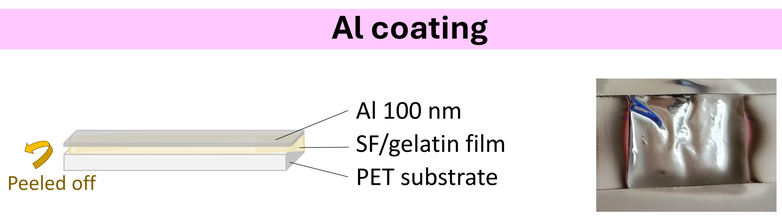
Spin coated SF/gel films at different blend percentages

Peel off and thickness of different SF/gel films

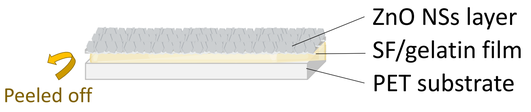


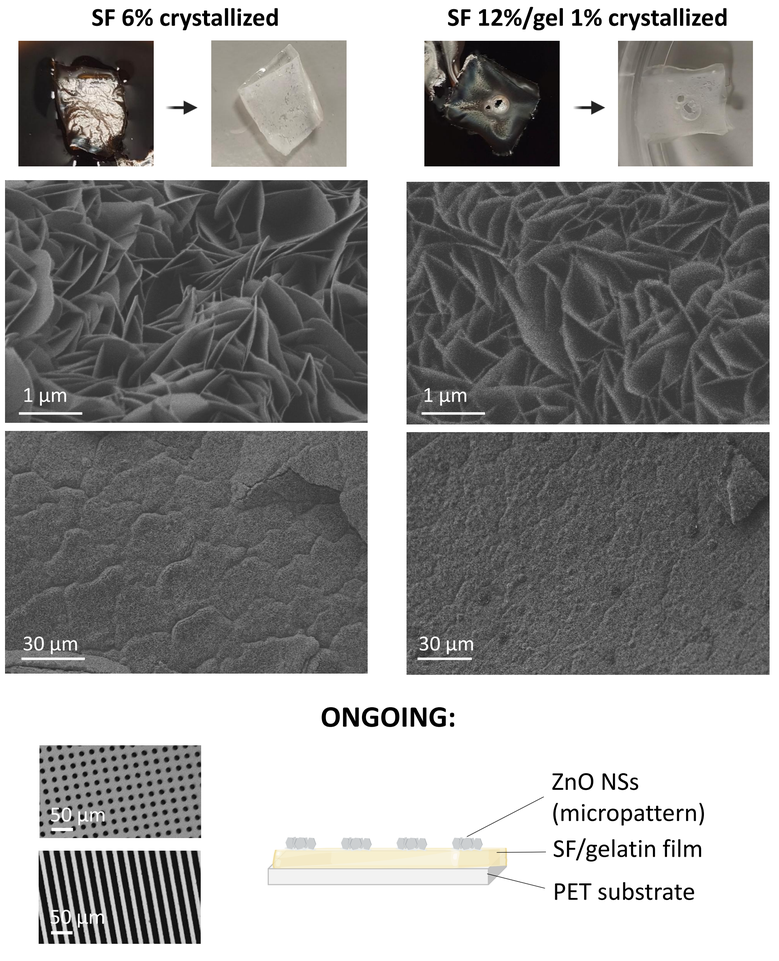


Al coating



ZnO NSs integration





ONGOING:

CONCLUSIONS:

- **Tunable degradation of SF/gel films** can be achieved by varying the relative percentages of SF and gelatin. Higher gelatin content and lower SF content result in faster hydrogel degradation.
- **Degradation** of spin-coated SF/gel films leads to **weight loss, surface morphological changes, and structural modifications**.
- SF/gel films spin-coated on PET substrates **can be peeled off** after dehydration. Film thickness increases with increasing SF and gelatin content, while **crystallization leads to more compact films**.
- **Integration of ZnO NSs on Al-coated SF/gel films** was successfully achieved via hydrothermal growth.

ACKNOGLEDGEMENTS:

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