# Nanofibers of core-shell structure with dual-release patterns of proteins

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**Statement of Purpose:** A unique core-shell structure by co-axial electrospinning can be served as drug delivery devices because encapsulated drugs in a core can be protected from harsh conditions. For co-axial electrospinning, a dual nozzle composed of an outer and an inner was employed to simultaneously electrospin both outer solution and inner solution.

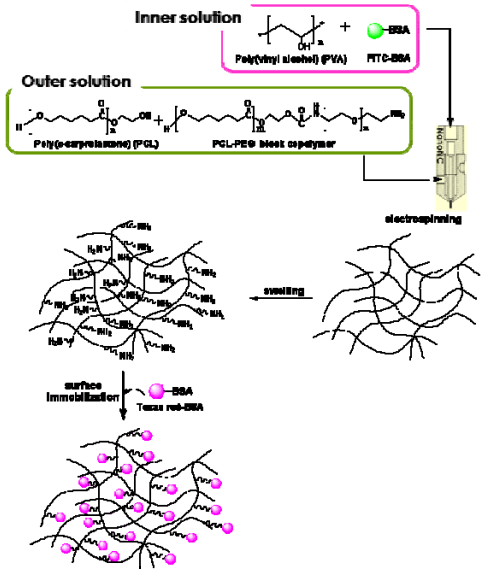


Figure 1. Schematic diagram of preparing nanofibers of core-shell structure for dual release patterns of proteins.

**Methods:** For coaxial electrospinning, a dual nozzle composed of an outer and an inner was employed to simultaneously electrospin both the outer solution and the inner solution. The outer solution was a mixture of poly(ε-caprolactone)-poly(ethylene glycol)[PCL-PEG] and poly(ε-caprolactone) [PCL] dissolved in a chloroform/MeOH mixture. For the inner solution, bovine serum albumin was dissolved in poly(vinyl alcohol) [PVA] solution at a concentration of 10mg/ml. Nanofibers of core-shell structure were examined under a field emission scanning electron microscope and a confocal laser scanning microscope. A release pattern of encapsulated or conjugated protein was examined by bicinchoninic acid [BCA] assay.

**Results:** Coaxial electrospinng successfully generated nanofibers with a core-shell structure. Fluorescent BSA was physically encapsulated in the nanofiber of core-shell structure, which was confirmed by confocal microscopy (data not shown). As a concentration of PVA in the inner solution increased, loading efficiency of protein within the core of nanofibers increased (Table 1). Electrospun nanofibers with flow rates ratios of 1:10 (in:out) showed higher encapsulation efficiency compared to those with 1:3 because of increased amounts of PCL composing nanofibers shells. PVA also affected release rates of encapsulated BSA, suggesting that PVA acted as a surfactant facilitating protein release. Proteins immobilized on the surface of nanofibers showed very slow release rates compared to encapsulated proteins. This could be attributed to chemical conjugation of proteins to surface-exposed amine groups of electrospun nanofibers.

Table 1. Loading efficiency (%) of encapsulated protein in nanofibers of core-shell structure.

| | | Outer solution | | | | | |
|---|---|---|---|---|---|---|---|
| | | PCL | | | PCL/PCL-PEG | | |
| Conc. of PVA[1] (%, w/w) | | 0 | 1 | 5 | 0 | 1 | 5 |
| Flow rates (inner sol'n-outer sol'n, ml/h) | 0.06-0.6 | 75.4± 1.5 | 80.0± 1.5 | 88.2± 11.6 | 74.9± 0.4 | 77.5± 1.6 | 93.6± 7.7 |
| | 0.1-1.0 | 55.3± 4.8 | 59.3± 3.2 | 66.9± 5.0 | 45.9± 0.5 | 50.2± 2.6 | 63.3± 2.8 |
| | 0.2-0.6 | 36.8± 9.9 | 35.8± 8.2 | 55.1± 9.9 | 32.1± 3.8 | 28.0± 4.1 | 40.8± 11.3 |
| | 0.3-1.0 | 34.0± 7.0 | 35.5± 11.9 | 34.7± 1.0 | 35.5± 5.9 | 29.9± 12.4 | 52.6± 10.4 |

[1]The concentrations of PVA as inner solution were changed 0, 1 and 5 %(w/w) and the concentration of BSA was 10mg/ml.

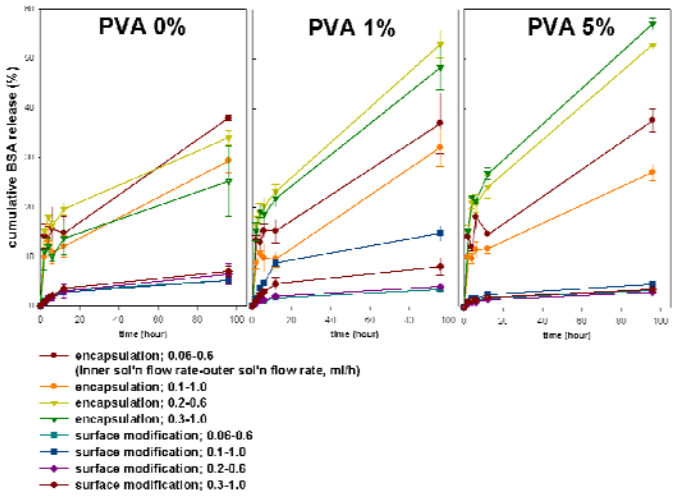


Figure 2. Release profile of encapsulated BSA inside and conjugated BSA from the nanofibers of core-shell structure.

**Conclusions:** Nanofibers with encapsulated proteins and immobilized proteins showed dual-release patterns of each proteins. While PVA and outer/inner flow rates ratios significantly affected release rates of encapsulated proteins, conjugated proteins on the surface of nanofibers showed negligible release rates.

**References:** [1] Diaz JE. Adv Funt Mater 2006;16:2110-2116.
[2] Zhang YZ. Biomacromolecules 2006;7:1049-1057.