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Degradation studies of spray coated polymer films using cantilever sensors

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Micromechanical sensors (cantilevers & strings) are versatile characterization tools for polymers

Miniaturized samples allow for fast and precise characterization of polymer degradation processes

Thin polymer layers are placed on cantilevers using a newly developed spray coating process

The spray coating process has been tested on cantilevers - polyvinylpyrrolidone (PVP) and poly (D, L-lactide)

Coating options

Blank cantilevers

Masks available for:

Partial coating of cantilevers e.g.

only coated at tip

only coated at the base

one or two cantilevers out of 8 left uncoated

Cantilever theory - 1

The eigenfrequencies

EI \frac{\partial^4 U(x,t)}{\partial x^4} + \rho A \frac{\partial^2 U(x,t)}{\partial t^2} = 0

f_n = \frac{\lambda_n^2 h}{2\pi L^2} \frac{E}{12\rho} = \frac{1}{2\pi} \sqrt{\frac{k_{eff}}{m_{eff}}} \ n = 1,2,...

where \lambda_n constants representing the eigenfrequencies

\lambda_n = 1.875, 4.694, 7.855,...; \ n = 1,2,3,...

The spraying is accomplished using ultrasonic spray coating. The ultra sound driven nozzle produces very small solution drops

The enzyme will adsorb to the PDLLA film in relatively short time which allow the degradation to continue after washing

Conclusions

• An understanding on how to find optimum spray coating conditions for producing uniform micrometer thick films on cantilevers has been established. One needs to be on the borderline between "dry" and "wet" regimes.

• As long as the flexural stiffness of the polymer coat is small compared to the silicon cantilever, the cantilever eigenfrequency is a measure of mass

• The degradation process has an induction period which is due to water swelling kinetics and possibly enzyme absorption kinetics on the polymer

• A versatile platform for fast polymer degradation investigations have been established

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