Phase Separated Polymer Blend Thin Film Scaffolds for Wound Healing Application

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Statement of Purpose: Blending biodegradable polymers offers the potential to fabricate new polymeric materials whose erosion kinetics and fabrication characteristics can be modified by varying blend composition. The phase separation process of a multicomponent blend is usually strongly influenced by the presence of an interface, which may lead to surface-oriented phase separation, or the formation of a wetting layer. Near interfacial boundaries, surface effects may lead to physical properties that significantly differ from those in bulk. In many practical applications, polymer films are prepared by a sudden extraction of a solvent. For the spin-coating technique, due to the intrinsic immiscibility of most macromolecular blends, polymer mixtures typically demix during the rapid solvent-casting process. The resulting phase-separated morphology may be far from thermodynamic equilibrium, and relaxation toward equilibrium may be hindered by kinetic barriers formed by the nonequilibrium phase morphology.Recently most researches of biodegradable polymers concentrated on the field of tissue engineering to create the temporary scaffolds required for cell growth and tissue regeneration[1,2]. Unfortunately, most of the polymers available today with unsuitable high Young's modulus and rather low elongation values at break. poly(L-lactide) (PLLA) blending with poly(DL-lactide-co-glycolide) (PLGA) can increase mechanical properties, prolong degradation time of PLGA. Such a system becomes quite interesting for tissue engineering study due to the unique morphology that can be formed with the special fabrication approach.

The domain structure in thin films of an immiscible PLLA/PLGA blend was studied after spin-casting from a common solvent. Atomic force microscopy (AFM) was used to obtain three-dimensional information on the domain morphology in thin films. Films with different component of polymer blends, at different concentrations and different spin-coating speeds were studied. Distinct differences in the thin film domain structure and surface morphology are observed depending on the component of the two polymers and the thickness of the film. These films are envisioned to be employed in wound healing via drug eluting films.

Methods:

PLLA, η_{inh}=0.9~1.2 dL/g in $CHCl_3$ (DurectCorporation)
PLGA, lactide: glycolide (75:25) (Aldrich) Mw: 50,000-75,000
For PLLA, PLGA, PLLA/PLGA blends dissolved in *p*-dioxane, the concentration is 3% (w/w), 5% (w/w) and 10% (w/w). PLLA50 represent the content of PLLA/PLGA (50/50), while the other blends are similar to this method.
Polymer films were prepared by the spin-coating technique from a PLLA/PLGA solution with different rotation speed, and then they were observed for morphology evaluation by AFM. The thickness of films was measured by Filmetrics (F20-UV).

Results:

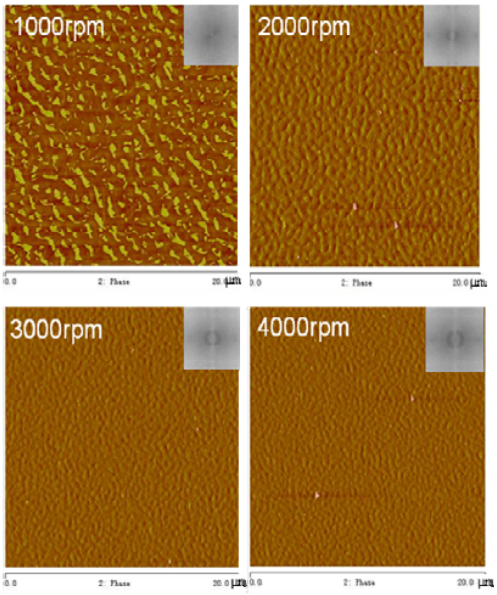

Figure 1 AFM phase images of PLLA/PLGA (50/50) blend films cast from 5% (w/w) *p*-dioxane solution with different rotation speed. The upside insert images are the 2DFFT of corresponding images.

Different component PLLA/PLGA blends scaffolds were fabricated by spin-coating technique. The morphology of these scaffolds were observed by AFM, distinct differences in the thin film domain structure and surface morphology are formed depending on the component of the two polymers and the thickness of the film. The thin films were annealed at designated temperature for different time, results show that the phase domain and the roughness of the scaffolds changed regularly. These films are envisioned to be employed in wound healing via drug eluting films.

Conclusions: Distinct differences in the thin film domain structure and surface morphology are observed depending on the component of the two polymers and the thickness of the film. FFT confirms that the pattern-directed composition variations coincide to the film thickness in a near linear response. Future studies will incorporate model drug molecular via elution for wound healing application.

References:

1) Tillman BW, Yazdani SK, Lee SJ, et al. Biomaterial. 2009; 30: 583–588.
2) Nowygrod R, Egorova N, Greco G,et al. J Vasc Surg 2006; 43: 205–16.