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Control of crystal morphology and orientation in nano-confined semi-crystalline polymer films to obtain superior barrier performance

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Several global megatrends are driving the need for packaging films that offer much more superior barrier to oxygen and water vapor transmission than have been traditionally achieved, whilst maintaining high levels of transparency. For food packaging applications targeting aluminum foil barrier performance, OTR and WVTR of approximately 10^{-2} cc/m^2-day-atm are typically required. The U.S. flexible packaging market was predicted to exceed $26.5 billion by 2010 with an annual growth rate of over 67 wt %. We have worked at understanding the parameters that control the transmission of small penetrant molecules through these thin transparent polymeric flexile barrier films, and how to design for high barrier performance. The dispersion of large aspect ratio impervious inclusions in an In-plane oriented morphology into these films lead to very high tortuosity and correspondingly very high barrier performance. A physical model that describes mechanistically the spatial control of crystallization kinetics in a nano-confined geometry using micro-layer technology to obtain predominantly "In-plane" lamellae orientation in semi-crystalline barrier polymer films was validated for providing up to 200X improvement in barrier performance.