Removal mechanism of polymeric films with nanostructured fluids:
effect of polymer molecular weight and polydispersity

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Polymer dissolution plays a key role in a wide variety of applications, such as photolithography, tissue engineering, design of drug delivery systems and, recently, conservation science [1]. Several efforts were made in the past to study polymer dissolution in presence of a solvent; however, these studies investigated only the removal process in simple systems consisting of polymer and a good solvent [2]. Our aim is the study of the cleaning mechanism in presence of complex ternary fluids, containing a good solvent, a non-solvent and surfactants, since they show optimal cleaning performances thanks to the cooperation between amphiphilic aggregates and the good solvent [3]. In particular, we want to investigate the effect of polymer molecular weight and polydispersity on both the cleaning mechanism and its kinetics. Different polyvinyl acetates (PVAc) with molecular weight in the range 75-855 kDa are characterized in terms of their chemical composition (FT-IR and NMR), crystallinity (X-ray diffraction) and thermal behaviour (differential scanning calorimetry); then, PVAc films are studied in order to characterize their morphology (AFM), chain mobility (FRAP experiments) and hydrophilic character (contact angle). Finally, these films are incubated with a cleaning fluid containing water, 2-butanone (MEK) as good solvent and a non-ionic surfactant (BioSoft N91-6) and the morphological changes occurring to the polymeric coating are followed by in situ confocal microscopy investigation. Our results show different interaction mechanisms between the polymer film and the liquid phase depending on $M_w$: in the case of lower $M_w$, we observe polymer removal, while for polymers with higher $M_w$ we observe only the swelling of the film. Furthermore, the kinetics of polymer removal seems to be strongly dependent on the polydispersity: high polydisperse systems show a faster dissolution rate with respect to the polymers with lower PDI.