Pdms 12.1 Sp4 Crack BEST 11

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premelting temperature of a thin chromium layer is of the order of 20 k and increases with increasing thickness of the layer to reach a value of 37k for a film 100nm thick. looking at the data it is also interesting to note that there is no significant difference in cracking between mesas etched at 0 degrees celsius and at 20 degrees celsius. thus, the photonic cracks are not just the product of thermal stress developed during laser annealing and a difference in t values at the two temperatures can be ruled out as an explanation of the cracking phenomena. considering that the irradiation temperature was fixed at 100 degrees celsius for all the samples, a difference in t has no material effect on cracking so the cracking is a purely surface phenomenon. we predict that the cracking occurs in the chromium layer because it has a t value lower than the premelting temperature of the chromium. the critical strain above which the chromium layer would melt is of the order of 1.5%. at this strain, the chromium will flow across the mesa ridges and the resulting shear stress in the chromium will cause it to crack. the critical strain value of the chromium layer on the top facet is the one that depends on the combination of the chromium thickness, the applied laser dose, and the silicon dioxide thickness. this critical strain value will also change as a function of the top t because this value is dependent on the angle of attack and the surface tension of the liquid chromium that can be estimated using the analysis in section 2.3. the behaviour of the critical strains of the chromium and silicon dioxide layers as a function of initial t are predicted in fig. 6g of the supplementary information and are compared to experimental data from refs 53, 54, 59, 60, 91 and 93. for silicon dioxide layers thicknesses up to 100nm the predicted behaviour closely match the data. for silicon dioxide thicknesses above 100nm the model should be modified because the peak of the t distribution needs to be changed. thus, it is not possible to modify the model and match the experimental data for a silicon dioxide thickness above 100nm. thus, the critical strain on top of the silicon dioxide layer remains constant at 1. we assume that this critical strain value will not change as the t on top of the silicon dioxide layer increases because, in the limit of higher temperatures, the silicon dioxide will start to melt and crack because the premelting temperature of silicon dioxide is of the order of 1100 k. the model predicts that the critical strain should not be significantly changed for chromium thicknesses above approximately 100nm (fig. 6g) if the silicon dioxide thickness is below 100nm (fig. 3d) because of the drop in t at the top of the silicon dioxide layer and the decrease of

the surface tension of liquid chromium. the comparison between the experimental data and the predicted values of critical strain are shown in table 1 and fig. 6g of the supplementary information.

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in particular, we demonstrate that the presence of the loading layer has no effect on the cracks. we also used a loading layer which is flexible enough to deform in order to ensure that the crack patterning process is repeatable and predictable. the process is likely to be applicable to all kinds of materials, however, further work will need to be undertaken to ensure that the size of the cracks can be controlled in a reproducible way. this ability to create reproducible cracks using this technique opens up the possibility of fabricating more complex patterning structures, which can be used as templates for other methods of patterning. after the determination of the different technological factors and their influence on the metallized surface, we now look at the 3d optical profile of the metallized pdms surface following the removal of the chromium/gold thin film. we observe that for the metallization process described here and illustrated in fig. 2 (b), the cracks are well more visible on the pdms surface. the crack network is composed of surface cracks having a similar profile to the spontaneously formed cracking of pdms surfaces at high plasma dose (see supplementary fig. 3 in the supplementary information) surrounding well-defined, non-cracked polygonal mesa features. this experimental observation appears to be in contradiction with the theoretical model developed by amiot et al. for the technologically induced cracking of thin films of polymers and metals 45 . it is clear that the cracks observed on the metallized pdms surfaces following the use of various thin film technologies (silicon, polymer, metal) are different in their fractal dimension. the thickness and the surface chemistry of the film, as well as the crack orientation relative to the direction of the applied strain, all play a role on the fractal dimension. furthermore, the cracks observed here are completely different from those observed for the technologically induced cracking of polymers and metals 45 . in the case of polymers and metals, the cracks form as a result of residual tensile stresses, while the cracks observed here appear to be caused by the presence of oxide thin films on the silica-like surface. the cracking of pdms has been well studied for many years 2, 3, 66, 67, 68, 69, 70, 71, 72, 73, 74 . in this case, the crack width has been reported to vary between 10nm and 1.5micron, but the crack spacing is always below 100nm. in addition, the crack formation is always a random process which is only dependent on the crack density. in this study, the cracks are observed to have a well defined fractal dimension which can be varied by changing the thickness and the chemistry of the metallic thin films. if we now consider the metallized samples where the pdms had been exposed to oxygen plasma a distinctive mud-crack patterning was observed for all samples over the oxygen plasma dose range studied see fig. 2bd. figure 2e shows a 3d optical profile of the cracked pdms surface following removal of the chromium/gold thin film. the mud-crack patterning is composed of surface cracks having a similar profile to the spontaneously formed cracking of pdms surfaces at high plasma dose (see supplementary fig. 3 in the supplementary information) surrounding well-defined, non-cracked polygonal mesa features. indeed, it is interesting to note that such mesa features, surrounded by a crack network, are free of nano-cracks and perfectly smooth as opposed to metallization of pdms not exposed to oxygen plasma (see fig. 2a). the mud-crack patterns observed for the metallized, plasma-exposed pdms samples strongly resemble those observed in nature 2, 3, 67, 68, 69, 70, 71, 72, 73, 74 . 5ec8ef588b

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