Atlas 46 – novel negative tone photoresist which combines the good properties of the established SU-8 and CAR 44

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The outstanding properties of SU-8 are well known to all users of microsystem technologies.[1] However, there is no version of SU-8 known which has nearly the same good properties and secondary is relatively easy removable. We have designed a solvent-developable negative resist Atlas 46 S ("S" for "solid"), following the SU-8, based on the reproducible raw material of a cresol novolac epoxy resin (see figure 1). Atlas 46 S layers exhibit a high reproducibility and shows once cross-linked a high stability against solvent attacks. Atlas 46 S is thus suitable for all applications in which the layer intended to remain permanently and highly stable on the substrate. It is possible to generate layer thicknesses ranging from a few to several hundred micrometers. The sensitivity of a 10 µm layer is in a range of 100 - 150 mJ/cm² with an aspect ratio of 1:3 (see figure 2).

We furthermore developed a second derivative; resist Atlas 46 R ("R" for "removable") which can patterned in a similar way. Atlas 46 R-layers can however be removed using commercial organic removers. We were able to combine all the advantages of both the SU-8 and the CAR 44 while cutting out the disadvantages present for some processes.[2] Due to the easy removability, the range of potential applications in photolithography is thus extended, for example the resist is highly suitable for galvanic applications. In addition, the sensitivity to different wavelengths can changed by variating the photo acid generator (PAG). With this new modular negative resist system even a multi-layer process can envisaged to form stable 3D structures from the same raw material by traditional lithography (see figure 3).

Another well investigated method to create 3D architectures with those materials is via double imprint lithography.[3]

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[1] Schütz, A. (2004). Untersuchungen zum Einsatz des Negativresistmaterials SU-8 in der LIGA-Technik. *Thesis, Dr. Ing., Technische Universität Berlin.*
[2] Schirmer, M. (07.05.2007-08.05.2007). Herstellung von Röntgenmasken in einem Zweistufenprozess mit dem Photoresist CAR 44. conference talk, Technologien und Werkstoffe der Mikro- und Nanosystemtechnik - *1. GMM-Workshop, Karlsruhe.*
[3] Steinberg C. et al. (2016). *Microelectron. Eng., 155*, 14-18.

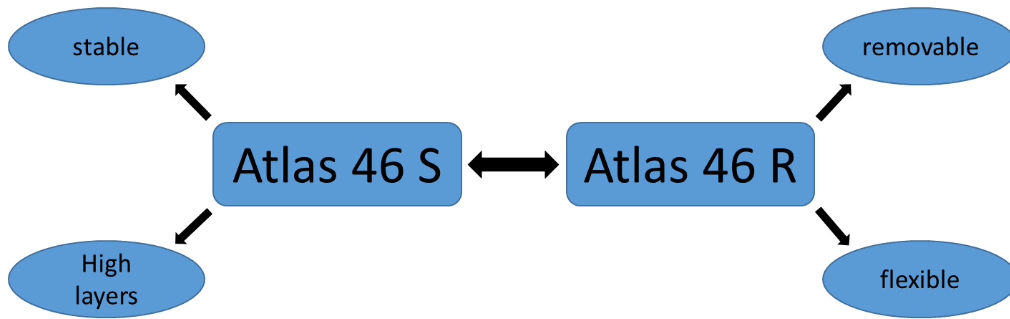

Figure 1: Main properties for the solid version (left side) and the removable version (right side) of Atlas 46.

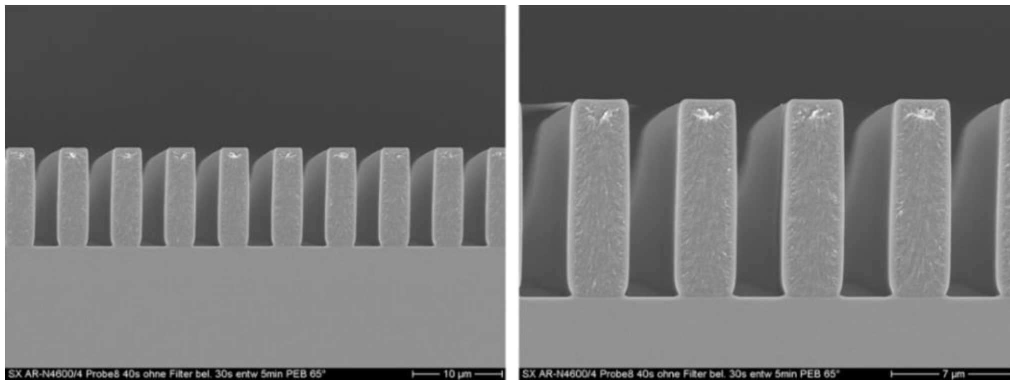

Figure 2: Vertical 10 µm bars based on negative resist Atlas 46.

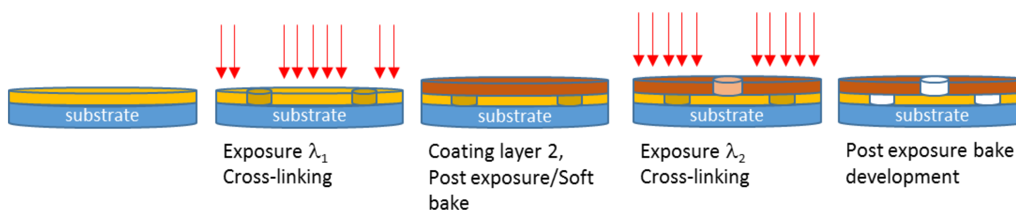

Figure 3: Processing for 3D structures with two types of Atlas 46. Spin coating of layer 1 containing PAG1 which is sensitive for λ_1, exposure with λ_1 followed by spin coating of layer 2 containing PAG2 which is sensitive for λ_2, exposure with λ_2, after post exposure bake and development the desired 3D architectures will be obtained.