Stabilizing Treatment of Negative Photoresist Films of the AZ nLOF20XX Series on Silicon

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Abstract

Films of negative photoresists (PR) AZ nLOF2020 and AZ nLOF2070 about 6.0 μm thick, deposited on the surface of monocrystalline silicon wafers by centrifugation, are studied using FTIR spectroscopy and microindentation methods. It is shown that after exposure to light with λ = 404 nm for 106 s and subsequent baking at 115°C for 60 s, a shift of the interference band maxima toward the high-energy region is observed in the reflection–absorption spectra of the photoresist films. It is caused by a decrease in the thickness of the PR film due to the evaporation of the solvent during baking. These processes occur more intensively in AZ nLOF2020 films, in which the shift of interference bands is ~9%, while in AZ nLOF2070 films it did not exceed 1%. It is shown that absorption bands with maxima at 1070 and 1100 cm^{-1}, caused by asymmetric and symmetric stretching vibrations of C–O–C bonds in aliphatic ethers, and at 2940 cm^{-1}, caused by asymmetric stretching vibrations of CH_3 bonds, are associated with the solvent. It is established that the microhardness of AZ nLOF20XX series films increases after stabilizing baking, which is due to the cross-linking of phenol–formaldehyde resin molecules, the base of the photoresist. The obtained experimental data are

explained by the ordering of the photoresist film structure near the PR/silicon interface due to the orientation of the molecules and the higher concentration of residual solvent in AZ nLOF2020.

REFERENCES

1. Lapshinov, B.A., *Tekhnologiya litograficheskikh protsessov. Uchebnoe posobie* (Technology of Lithographic Processes: A Textbook), Moscow, 2011.

2. AZ nLOF 20xx negative resist. www.microchemicals.com/products/photoresists.

3. Brinkevich, D.I., Grinyuk, E.V., Prosolovich, V.S., Zubova, O.A., Kolos, V.V., Brinkevich, S.D., and Vabishchevich, S.A., AZ nLOF series of photoresist films on monocrystalline silicon, *Russ. Microelectron.*, 2025, vol. 54, no. 1, pp. 1–7. https://doi.org/10.1134/s1063739725600189

   Article **Google Scholar**

4. Brinkevich, D.I., Grinyuk, E.V., Prosolovich, V.S., Brinkevich, S.D., Kolos, V.V., and Zubova, O.A., Reflective absorption IR Fourier-spectroscopy of photoresistive films on silicon, *Pribory i Metody Izmerenii*, 2025, vol. 16, no. 1, pp. 242–250. https://doi.org/10.21122/2220-9506-2025-16-1-242-250

   Article **Google Scholar**

5. Pratsenka, S.V., Voropai, E.S., and Belkin, V.G., Determination of the ability to measure traces of water in dehydrated residues of waste water by IR diffuse reflectance spectra, *J. Appl. Spectrosc.*, 2018, vol. 84, no. 6, pp. 1081–1083. https://doi.org/10.1007/s10812-018-0591-y

   Article **Google Scholar**

6. Brinkevich, D.I., Prosolovich, V.S., Kolos, V.V., Zubova, O.A., and Vabishchevich, S.A., Infrared Fourier spectroscopy of diffuse reflection of the az nlof series negative photoresists films on monocrystalline silicon, *Vestnik Polotskogo Gosudarstvennogo Universiteta. Seriya C. Fundamental'nye Nauki. Fizika*, 2024, no. 2, pp. 34–40. https://doi.org/10.52928/2070-1624-2024-43-2-34-40

7. Brinkevich, S.D., Grinyuk, E.V., Brinkevich, D.I., and Prosolovich, V.S., Modification of diazoquinone–novolac photoresist films beyond the region of implantation of B+ ions, *High Energy Chem.*, 2020, vol. 54, no. 5, pp. 342–351. https://doi.org/10.1134/s0018143920050045

Article **Google Scholar**

8. Vabishchevich, S.A., Vabishchevich, N.V., and Brinkevich, D.I., Microhardness of silicon sheets, subjected to gettering treatment, *J. Adv. Mater.*, 2005, vol. 12, no. 2, pp. 125–128.

Google Scholar

9. Tarasevich, B.N., *IK spektry osnovnykh klassov organicheskikh soedinenii. Spravochnye materialy* (IR Spectra of Main Classes of Organic Compounds: Reference Materials), Moscow: Moskovskii Gosudarstvennyi Universitet, 2012.

10. Brinkevich, D.I., Grinyuk, E.V., Brinkevich, S.D., Prosolovich, V.S., Kolos, V.V., Zubova, O.A., and Lastovskii, S.B., Fourier-IR spectroscopy of photoresist/silicon structures for explosive lithography, *J. Appl. Spectrosc.*, 2024, vol. 90, no. 6, pp. 1223–1228. https://doi.org/10.1007/s10812-024-01657-4

Article **Google Scholar**

11. Poljanšek, I., Šebenik, U., and Krajnc, M., Characterization of phenol–urea–formaldehyde resin by inline FTIR spectroscopy, *J. Appl. Polym. Sci.*, 2006, vol. 99, no. 5, pp. 2016–2028. https://doi.org/10.1002/app.22161

Article **Google Scholar**

12. Brinkevich, D.I., Prasalovich, U.S., and Yankouski, Yu.N., Modification of diazoquinone-novolac photoresist films by boron ion implantation, *Zhurnal Belorusskogo Gosudarstvennogo Universiteta*, 2020, no. 2, pp. 62–69. https://doi.org/10.33581/2520-2243-2020-2-62-69

13. Garcia, I.T.S., Zawislak, F.C., and Samios, D., The effects of nuclear and electronic stopping powers on ion irradiated novolac–diazoquinone films, *Appl. Surf. Sci.*, 2004, vol. 228, nos. 1–4, pp. 63–76. https://doi.org/10.1016/j.apsusc.2003.12.027

Article **Google Scholar**

14. Brinkevich, D.I., Brinkevich, S.D., Petlitsky, A.N., and Prosolovich, V.S., Transformation of the spectra of a attenuated total reflection when drying a diazoquinone-novolach photoresist, *Russ. Microelectron.*, 2021, vol. 50, no. 4, pp. 239–245. https://doi.org/10.1134/s106373972104003x

Article **Google Scholar**

15. Shugurov, A.R., Panin, A.V., and Oskomov, K.V., Specific features of the determination of the mechanical characteristics of thin films by the nanoindentation technique, *Phys. Solid State*, 2008, vol. 50, no. 6, pp. 1050–1055. https://doi.org/10.1134/s1063783408060097

Article **Google Scholar**

16. Vlasov, S.V. and Kuliznev, V.N., *Orientirovannoe sostoyanie polimerov* (Oriented State of Polymers), Moscow: Znanie, 1987.

17. Brinkevich, S.D., Grinyuk, E.V., Brinkevich, D.I., Sverdlov, R.L., Prosolovich, V.S., and Pyatlitski, A.N., Mechanism of the adhesive interaction of diazoquinone-novolac photoresist films with monocrystalline silicon, *J. Appl. Spectrosc.*, 2020, vol. 87, no. 4, pp. 647–651. https://doi.org/10.1007/s10812-020-01049-4

Article **Google Scholar**

18. Aleksandrov, O.V. and Dusj, A.I., Effect of silicon-surface orientation in the bulk model of thermal oxidation, *Semiconductors*, 2009, vol. 43, no. 10, pp. 1373–1378. https://doi.org/10.1134/s1063782609100212

Article **Google Scholar**

19. Zhang, X.G., *Electrochemistry of Silicon and Its Oxide*, New York: Kluwer, 2001.

Google Scholar

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Ethics declarations

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