Physical development of Lippman emulsions (G)

Research Disclosure Database Number 125001
(Research Disclosure Journal Number : 12501)

Published in September 1974

Research Disclosure Journal, ISSN 0374-4353. © Kenneth Mason Publications Ltd
The Book Barn, Westbourne, Hants. PO10 8RS. UK
Tel: +44 (0)1243-377977 Fax: +44 (0)1243-379136
e-mail : info@ResearchDisclosure.com

Physical development of Lippmann emulsions (G)
12501

Photographic materials for microelectronic mask-making should have a high resolving power in order to allow a correct reproduction of the dimensions of the image. For this purpose, it is known to use photographic silver halide elements comprising a support, especially glass supports in view of their high dimensional stability, coated with a silver halide emulsion layer of the Lippmann type ie an emulsion having an average grain size of 100 nm or less.

The image-sharpness of the masks produced, both on reversal and negative processing, does not always meet the requirements, especially where reproduction of very fine image details is concerned. Apart from the disadvantageous effect of light-scattering within the emulsion layer, which can be reduced by the use of light-screening dyes, there may be another cause for lack of sharpness namely the granularity of the silver image. The filamentary structure of the silver produced upon development may indeed cause unsharpness especially at the edges of very fine image details.

In the interest of image sharpness development can be adapted so that the silver particles grow more at equal rates in all directions resulting in a developed image composed of compact rounded particles rather than the formation of a filamentary silver image (see Mees and James, The Theory of the Photographic Process, 3rd Ed, 1966, Chapter 15 – The Mechanism of Development, p 324 - 332).

Instead of chemical or direct development of the exposed photographic elements for microelectronic mask making, the exposed elements can be subjected to physical development which promotes the formation of nearly spherical silver rather than filamentary silver. It is known that in physical development the development centres formed by exposure are grown by depositing thereon metallic silver or another metal from the developing solution containing a soluble metal salt or complex as a source of free metal ions eg silver nitrate and a reducing agent which is normally an ordinary developing agent such as hydroquinone, metol, p-amino-phenol or p-phenylene diamine developing agents.

Pure physical development occurs by means of a solution comprising an ordinary developing agent and a soluble silver salt eg silver nitrate as well as additions to adjust pH and silver ion concentration to suitable values eg for the latter purpose silver complex forming substances such as sulphites, thiocyanates, thiosulphates, etc. However, it is also possible to use solutions containing no added soluble silver salt but according to which silver ions from the silver halide grains pass into solution and thus contribute silver to the developed images (this is known as solution physical development). These solutions can be ordinary photographic developers having high solvent activity for silver salts eg by the presence of silver complexing agents such as thiocyanates, sulphites, thiosulphates, etc.

For improving the sharpness of the developed image by reducing or eliminating the formation of filamentary silver during development it is also possible to start development with a developing solution of low solvent action for silver halide, which is a pure chemical development and then continue development with a solution of high solvent action for silver halide, that acts largely by solution physical development. Alternately, the exposed photographic material is first slightly chemically developed so as to form more spherical-like silver instead of filamentary silver, whereupon the density is increased by treatment with a purely physical developer containing a soluble silver salt and a developing agent.

The physical development methods described hereinbefore for exposed photographic elements for microelectronic mask-making may be used for the formation of negative as well as reversal images. For the latter purpose, the exposed silver halide is developed chemically, the developed silver is bleached out, the remaining unexposed silver halide is rendered developable eg by an overall exposure and the silver halide is then subjected to physical development by methods as referred to hereinbefore.

Disclosed anonymously
12501