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## **Photochromatic Images of Edmond Becquerel: Where do the Colors Come From? Tracks in the Understanding of the Origin of their Colors**

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Edmond Becquerel (French physicist, 1820-1891) introduced in 1848 the first color photographs called by himself, “photochromatic images”. Among the first images was the recording of the solar spectrum he produced by directly projecting it onto a sensitized silver plate [1, 2, 3]. At least, two examples of this solar spectrum image are kept in museum collections, one at the Musée Nicéphore Niépce (Châlon-sur-Saône, France) and the other one at Musée des arts et métiers (CNAM, Paris). However photochromatic images are still light sensitive and have to be kept in the dark [4]. Becquerel wrote he had not yet “been able to arrest the subsequent action of diffused light which gradually destroys the images” [5]. Despite many attempts, Becquerel and other followers such as Abel Niépce de Saint Victor (1805-1870) who revisited Becquerel's process in the 1850s and the 1860s, never managed to make them light stable. The long exposure times required to produce the image and its light instability prevented the diffusion of the process among the public at large. A small number of photochromatic images have survived till today. The recent rediscovery of a batch of these early color photographs in the archives of the National museum of natural history in Paris has brought a new interest for this process in particular to better understand the origin of the colors. Interestingly, if many hypotheses have been stated, the origin of colors has never been clearly demonstrated, and even scientifically re-explored since the 19th century, except a first study in 1999 [6]. A preliminary study funded by “Sorbonne Universités” and gathering different laboratories is endeavoring to reexamine those intriguing images. Our paper will describe this initiative, from the production of photochromatic images following Becquerel's publications to its analysis. The direct printing-out positive color images are prepared in a very simple way that requires no development: a polished silver plate is sensitized by a chlorine solution and then exposed to the light in the camera. We studied parameters described by Becquerel to play a role in the formation of the images: the preparation of the silver plate, the thickness of the sensitized layer, the visible spectral bandwidths of the exposure, etc. We examined the relationship between the image microstructure and its optical properties. The microstructure of the colored plates, the sensitized layer thickness, its morphology, and its porosity, as many characteristics that control the colors were investigated by using electron microscopies. Our multi-scale approach, from the naked-eye view to a sub-microscopic scale, will help us to relate the macro and micro-images to the reflectance properties measured with UV-Visible reflectance spectroscopy. This leads to a better understanding of the origins of the colors [7].

[1] Becquerel, E. *Annales de Chimie et de Physique*, 22:451–459, 1848.

[2] Becquerel, E. « Chapitre IV. Reproduction des couleurs par l'action de la lumière ». In *La lumière, ses causes et ses effets. Tome second : Effets de la lumière. Livre III : Photographie*, 209–34. Paris: F. Didot frères, fils et Cie, 1867. <http://gallica.bnf.fr/ark:/12148/bpt6k90369m>. [Online; accessed 10-Oct.-2018]

[3] <http://www.museeniepce.com/index.php?/collections/enjeux-de-la-photographie/L-utopie-photographique>. [Online; accessed 10-Oct.-2018]

- [4] Lavédrine, B. and Gandolfo, J.-P. L'autochrome Lumière. Secrets d'atelier et défis industriels. Paris : CTHS, 2009.
- [5] Becquerel, E. *Photographic and Fine Art Journal*, 8:8, 1855.
- [6] Kereun, M. « L'héliochrome, précurseur de la photographie couleur ». Colloque Rencontres Autrement. Nancy, 1999.
- [7] de Seauve, V. A l'origine des couleurs des images photochromatiques d'Edmond Becquerel : étude par spectroscopies et microscopies électroniques, Thèse de doctorat, sous la direction de M.-A. Languille et B. Lavédrine, Université Paris-Sciences-et-Lettres, 2018.

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