New Craze Testing Method

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Abstract

Coated paper printed with black indigo shows marked crazing or fold cracking as it is known in offset printing. Photographic paper (silver salt) exhibit a magenta line in the fold after being turned umpteen times. E-PHOTO paper (Felix Schoeller Digital Media) printed with indigo exhibits neither crazing nor magenta crazing according to the findings gathered by Felix Schoeller Digital Media.

PTS has been commissioned to develop a standardised method (PTS Craze Test) and to conduct it on three paper samples in order to determine the differences in the crazing behaviour of paper used in the photo album sector. This method must be conducted under pre-defined conditions and serve as certification of the above-mentioned problem area by virtue of its reproducibility.

Methodological approach

Whenever paper is folded, defects occur at the site of the fold, i.e. the coating is damaged in these areas. In the case of paper that is fully printed (photographic paper in this case), the damaged areas correspond to the lighter, unprinted areas. This effect shall be designed in the following as crazing.

The following instruments were used to evaluate crazing:

- K-CONTROL-COATER base unit K 303, Model 625, from Messrs. Erichsen, with a calibration blade
- A microscope from Messrs. Keyence "VHX-500" equipped with a "VH-Z 20 R" lens.

The subject matter of the study was three different paper samples with A4 format. All papers were all-over black prints. The three paper variations were defined as follows:

1. Silver salt photographic paper
2. Coated halftone printing paper
3. E-Photo

The material was treated and evaluated as set forth below. The printed papers were cut to a size of 208 mm x 60 mm. The sample strips were folded using the Erichsen Coater.

The opposing edges of the sample were superimposed on one another and clamped in the coater. The fold was executed with the calibration blade at speed setting "3".

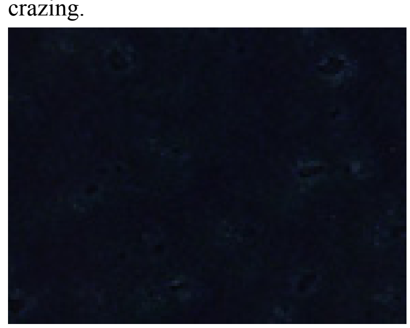
The sample strip was removed, unfolded and reclamped in the machine with the printed side up and smoothed using the calibration blade. By repeating this procedure, several folds were produced at exactly the same location on the sample.

The crazed areas were measured using a "VHX-500" microscope. The instrument has integrated image analysis software that can be used to determine and calculate the different areas. It provides the number of measured areas, the sums of the areas, the surface ratio expressed in % and total surface area expressed in µm². All values can be exported into a CSV file and processed further in a spreadsheet.

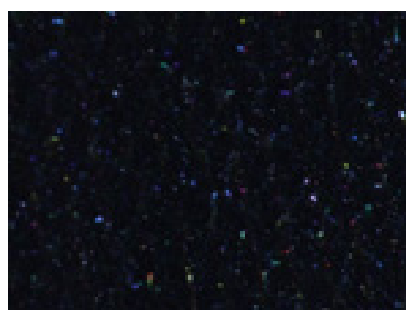
Results

Microscopic examination of crazing

Images of three different paper grades without folds were prepared as a reference for the microscopic examination of crazing.



Silver salt photographic paper



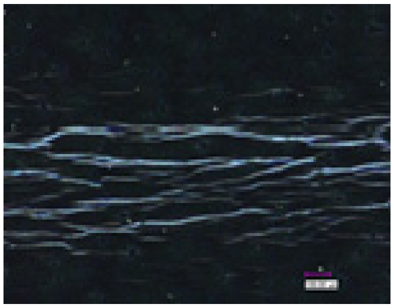
Coated halftone printing paper

E-Photo

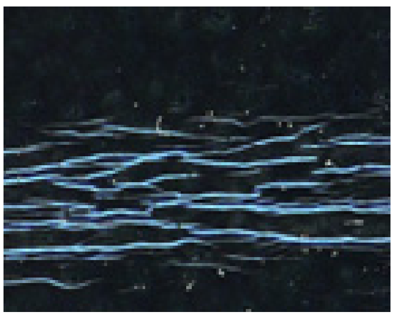
The reference images functioned as the zero value when the crazed area was later evaluated.

Silver salt photographic paper

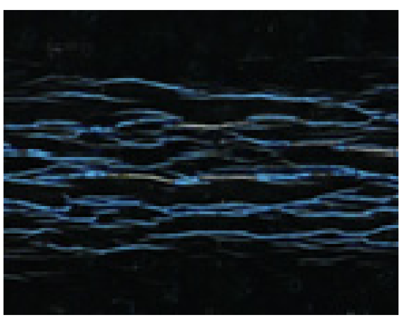
The following pictures shows the microscopic images magnified 100x of the silver salt photographic paper with varying number of folds.



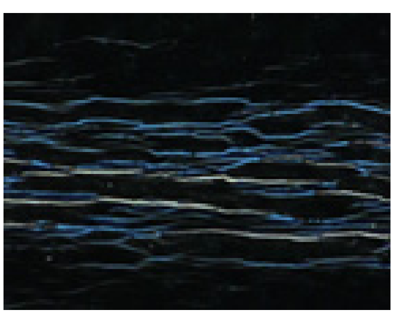
No. of folds: 1



No. of folds: 5



No. of folds: 20

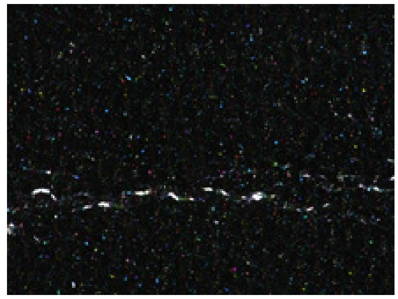


No. of folds: 50

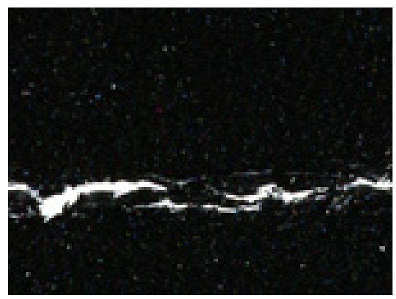
Significant crazing was evident even after the first fold was made. Crazing increased as additional folds were made at the same location.

Coated halftone printing paper

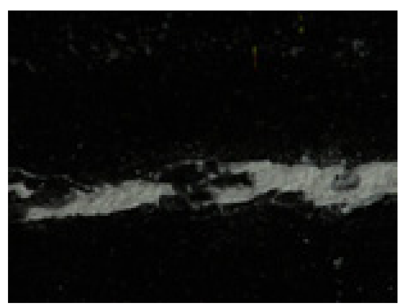
The pictures below shows microscopic images magnified 100x of the coated halftone printing paper with varying number of folds.



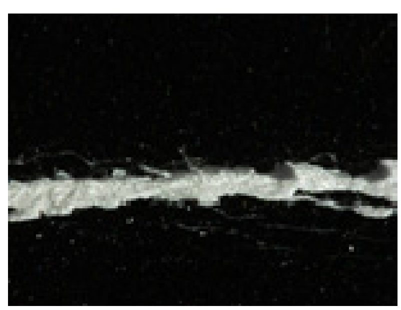
No. of folds: 1



No. of folds: 5



No. of folds: 20

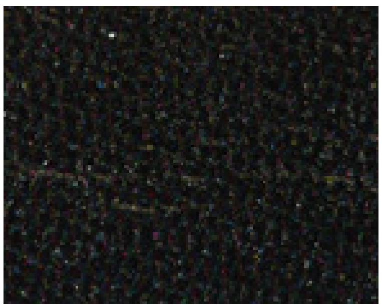


No. of folds: 50

Crazing became evident even after the first fold was made. Here as well, crazing increased as additional folds were made at the same location. However, after more than 5 folds, the coat clearly split so that areas without any ink receiving substrate developed within the folded area. These areas can be seen with the naked eye, even without the use of a microscope.

E-Photo

The pictures below shows microscopic images magnified 100x of the “E-Photo” paper with varying number of folds. Unlike both the other papers that were examined, there was no crazing of the “E-Photo” paper. Even after making 50 folds at the same location, no cracking of the coating layer or any other defects could be detected under the microscope.



No. of folds: 1

No. of folds: 5

No. of folds: 20

No. of folds: 50

Evaluation of the crazed surface

Quantitative evaluation:

The crazed areas of the different papers with the varying number of folds can be compared quantitatively by image analytical processing. The unit of measure that is used here is either the percentage surface ratio of crazed area to undamaged area within the measuring range or the surface area of the crazing expressed in mm per meter of fold [mm²/m].

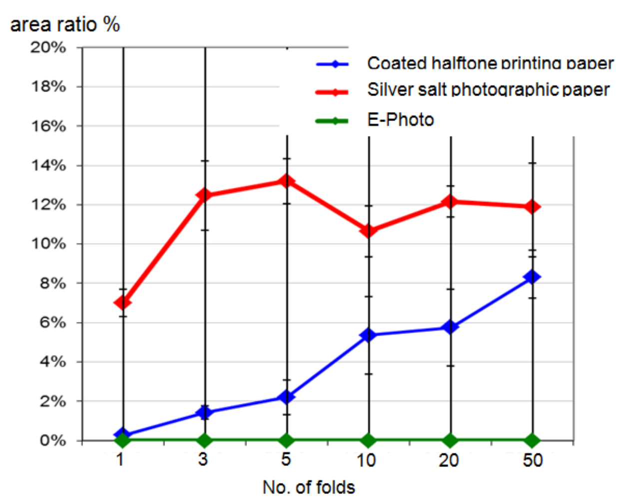
Surface ratio [%]:

After processing the crazed areas to form a corresponding surface ratio, the “E-Photo” paper exhibited the value 0 even after being folded 50 times. Hence, no crazing could be verified for “E-Photo”.

The silver salt photographic paper showed more than 13% crazing even after being folded only 5 times. This value, however, did not increase even after additional folds had been made.

The coated halftone printing paper showed approx. 2 % crazing after being folded 5 times. After additional folds had been made, this value increased to more than 8% (50x folding).

The diagram below shows the quantitative relationships in the crazing behavior of the three paper samples that were examined.



Conversion in mm²/m:

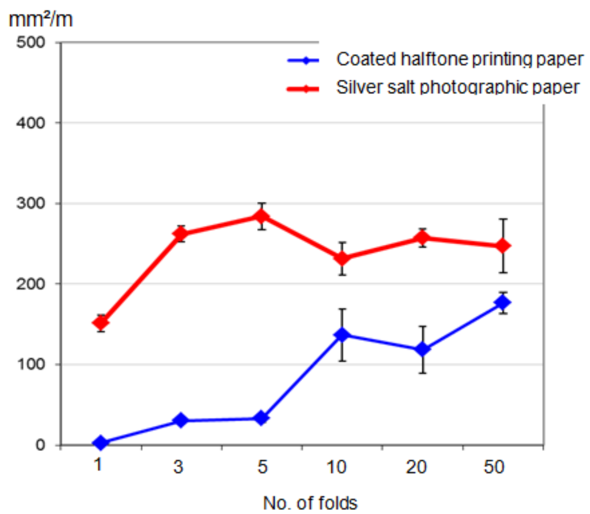
In order to demonstrate the tendency to craze irrespective of the surrounding field of measurement, the surface ratio illustrated can be converted to an area per length of fold.

The "E-Photo" paper exhibited a constant value of 0 mm²/m crazing over the total number of folds.

The silver salt photographic paper exhibited maximum crazing of 275 mm²/m. This value was achieved after the paper had been folded 5 times.

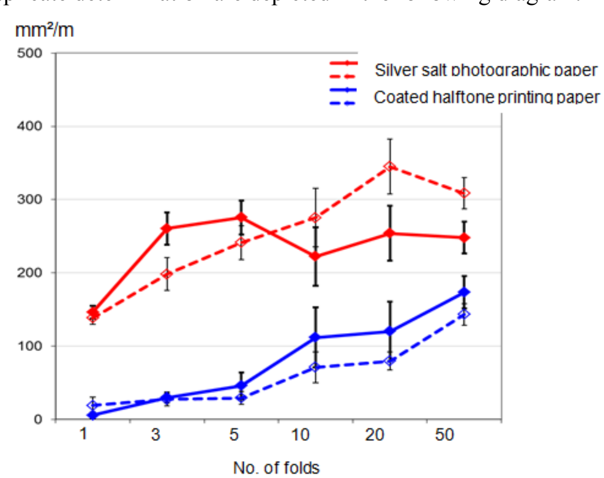
The coated halftone printing paper attained a crazing value of 143 mm²/m after it had been folded 50 times.

The following diagram shows the crazing values as a function of the number of folds and the paper tested. The "E-Photo" paper was not taken into account owing to its continuous crazing value of 0 mm²/m.



Reproducibility

In order to ensure the reproducibility of the study, all examinations were repeated once again. The results of this duplicate determination are depicted in the following diagram.



The "E-Photo" paper showed a crazing value of 0 mm²/m, just like in the previous test, and was therefore not included in the diagram.

During the second test, the "silver salt photographic paper" did not reach its maximum until after having been folded 20 times. The maximum crazing value amounted to 345 mm²/m in this case.

The "coated halftone printing paper" exhibited the same behaviour as in the first test. The maximum crazing value amounted to 120 mm²/m after having been folded 50 times.

The crazing behaviour of the various paper samples can be reproduced by means of the measurement and evaluation methods used during testing.

Conclusion

Creating a measurement methodology:

The "crazing" measurement methodology was developed within the scope of this study. The method was validated and used accordingly on the three paper samples.

Crazing:

The three paper samples that were tested were able to be clearly distinguished by means of the crazing methodology.

The "E-Photo" paper was ranked the best of the three paper grades. This paper did not show any crazing. The "coated halftone printing paper" was the second worst paper grade and exhibited a significant and increasingly strong crazing tendency depending on the number of folds. The "silver salt photographic paper" was ranked the worst paper of all. Pronounced, clear crazing occurred in this sample even after only a few folds had been made.

Author Biography

Dirk Fiedler, born 1970, graduating in biotechnology from the College of Technology in Hamburg-Bergedorf, Germany. Presently, he is head of department of surfaces and print at PTS, Heidenau, Germany. His main focus is on development high-quality products and the solving of problems associated with all common printing methods.

Wolfgang A. Schmidt, born 1954, holds a Ph.D. in inorganic and solid state chemistry from the University of Siegen, Germany. Presently, he is patents/IP manager at specialty paper manufacturer Schoeller Technocell, Osnabrück, Germany, also responsible for several public funded basic R&D projects with external partners. His main focus is on imaging and printing media as well as on substrates for technical applications. He is co-president of IS&T Chapter Europe.

Petra Behnsen, born 1968, graduating in biotechnology from the College of Technology in Köthen. She worked as scientific assistant in the field of mechanical process engineering, environmental and paper technology in different companies. Petra Behnsen joined the metrology team of PTS Heidenau in 2001, concentrating on spectroscopic analyses for several years. At the end of 2007 she joined the surface technology department of PTS, where she is able to use her expertise in the measurement and analysis of special surface coatings for the development of functional surfaces. At present she is dealing primarily with boric acid-free solutions for chemical cross-linking, various cross-linking technologies and the special functionalizing of coatings.

Yvonne Gierth, born 1974, is technican for chemistry since 20 years. She worked in the production and the laboratory. Since 2012 she works in PTS, her expertise is in apply coatings and carry out various analyzes.