



Long Term Archivability and Stability of Fujifilm Magnetic Tape Using Barium-Ferrite (BaFe) Particle

FUJIFILM Corporation has proven that more than a 30 year archival period is possible with Fujifilm's unique Barium-Ferrite (BaFe) tape and that the tape is stable and reliable after such time period.

Due to internal controls and regulations, the amount of long term archival data is increasing every year. Since magnetic tape does not need to be periodically operated or connected to a power source, there will be no data loss because of performance degradation due to the drive actuator. This means magnetic tape is a reliable long term storage solution.

Magnetic tape uses magnetic particles as a recording medium. For further capacity and expansion of magnetic tape, it is necessary to micrify the particle size and increase the recording density. Today, metal particle tape is the most popular among the magnetic media market. However with metal particle, it is extremely difficult to maintain each particle's magnetic force when using microscopic particles in order to increase the recording capacity. Therefore ahead of other media manufacturers, Fujifilm has advanced the development of BaFe particles. This advanced development aims to keep higher coercivity (using micro fine particles), lower noise, higher frequency characteristics and superior storage performance in comparison to other metal particles.

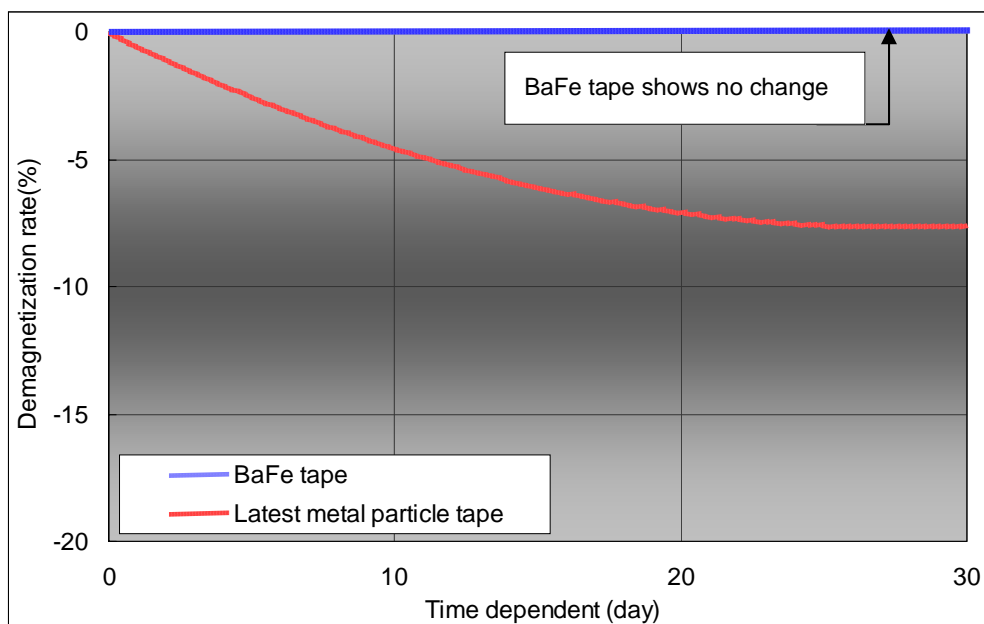
Fujifilm performed their original accelerated evaluation (temperature 60°C, relative humidity 90%, 30 days) in order to confirm the changes of demagnetization, friction coefficient and tape surface over time. In addition, a storage test in a polluted environment ("Battelle experiment") was performed. Through this series of testing, it was proven that the data storage of 30 years or more with BaFe particle is possible and the tape can maintain its magnetic characteristics for long term storage.

1. Accelerated evaluation: Amount of demagnetization comparison

BaFe tape and the latest metal particle tape were stored under 60°C/90% relative humidity environment for 30 days to measure the changes of demagnetization. After 30 days, which corresponds to 30 years when stored naturally¹, there was no change in the amount of demagnetization with BaFe tape, proving that it can maintain its magnetic property for more than 30 years (Fig.1). Under the same testing conditions, although a decrease in the amount of magnetization can be seen in the latest metal particle tape, there is no impact on read and write performance. BaFe tape shows even better performance than metal particle tape as it is oxide and is chemically stable. Therefore, influencers within a storage environment do not affect the stability of the magnetic properties under long term storage conditions.

Fig. 1: Change in the amount of demagnetization for BaFe tape and metal particle tape

According to Fujifilm testing, BaFe shows no change in the amount of demagnetization.



¹ Magnetic properties have actually been measured in metal particle media which was manufactured in 1985. It was proven that one day corresponds to one year of ambient storage when testing the same media in a 60°C/90%RH environment.

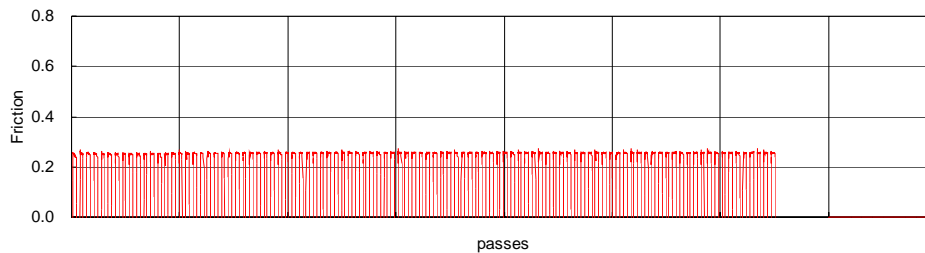
2. Accelerated evaluation: Change in tape surface and friction coefficient

BaFe tape was stored under 60°C/90% relative humidity environment for 30 days. A Differential Interference Contrast (DIC) microscope was periodically used to monitor the tape surface. As a result, there was no surface extraction which is usually the cause of errors or drop-outs². In addition, friction coefficient was measured using an AlTiC³ cylinder which is made of the same material as an actual drive head. The BaFe tape was run while wrapping its surface around the AlTiC and the change in friction coefficient was measured over time. The results show that there was no change in the friction coefficient (Fig. 2). Moreover, the AlTiC cylinder which was used in the friction testing was monitored using DIC and there was no increase in the amount of debris from the tape which is usually the cause of errors or drop-outs. Therefore, these results verify that BaFe media is stable and can be run after 30 years of archival storage.

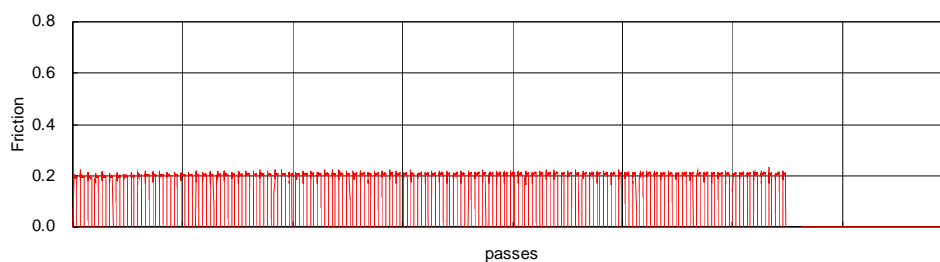
Fig. 2 - Change in friction coefficient of BaFe tape

Fujifilm tests show there was no change in the friction coefficient. This indicates that BaFe is stable and can be run after long term storage.

Before:



After:



² Drop-out is a momentary defect caused by a temporary loss of signal.

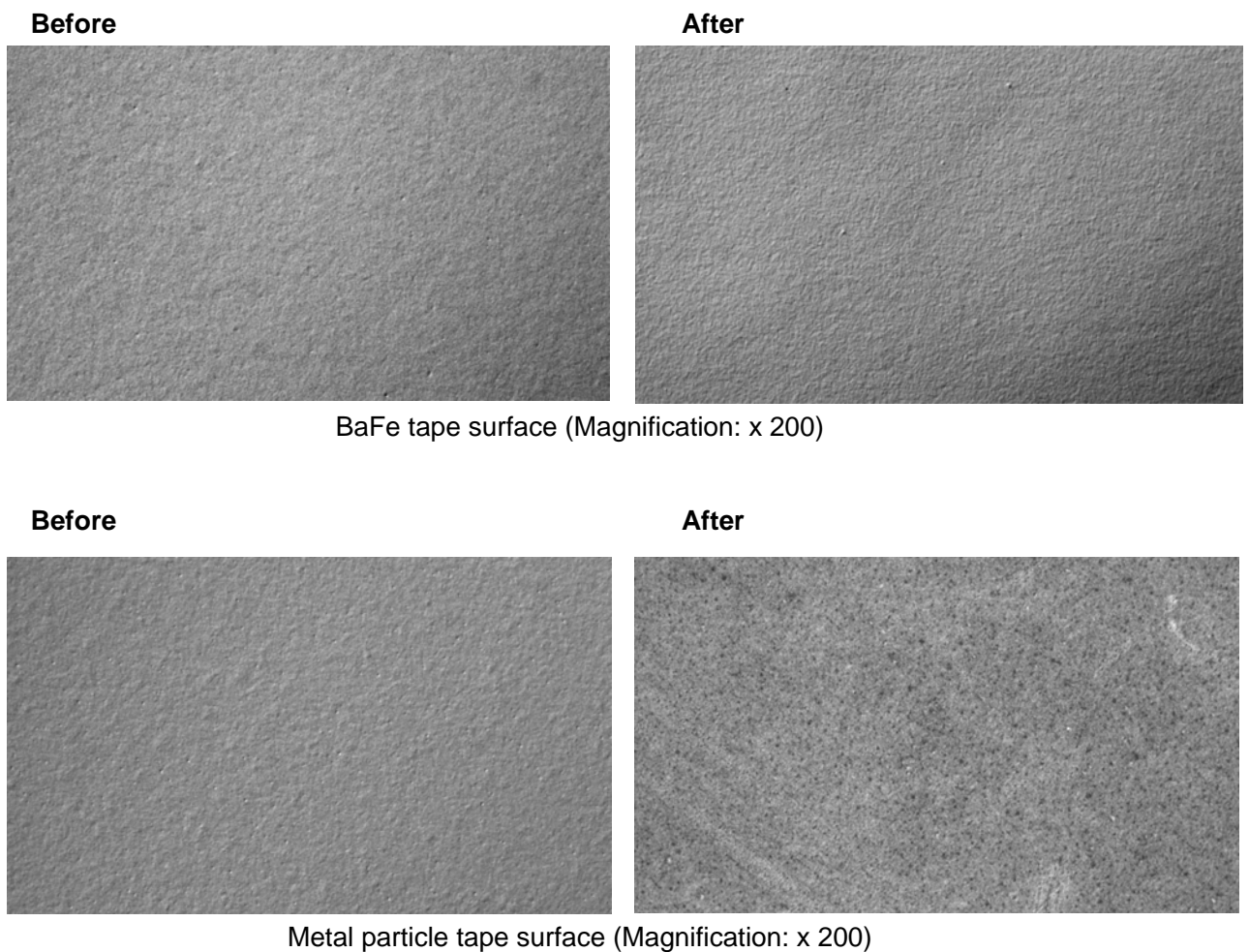
³ AlTiC is Alumina Titanium Carbide (AlO₂/TiC ceramic).

3. Storing test under corrosive gas environment: “Battelle evaluation”

A “Battelle test”⁴ simulates the change in BaFe tape and metal particle tape over time. This test was performed in a polluted environment generating the corrosive gas chlorine. It was confirmed that there was no corrosion on the BaFe tape surface even when it was left in the corrosive gas for 14 days (Fig. 3). Furthermore, there was no decrease in the amount of magnetization. This proves that BaFe tape is stable for long term storage even after exposure to a polluted environment.

Fig. 3 - Change in the tape surface in a corrosive gas environment using Differential Interference Contrast (DIC) Microscope

Tests performed by Fujifilm show there was no change in BaFe tape surface after storing it in a corrosive gas environment. However, corrosion can be seen on the metal particle tape surface.



⁴ Test condition – H₂S 10ppb, NO₂ 200ppb, Cl₂ 10ppb at 30°C/70% relative humidity for 14 days.

The “Battelle test” was originally used to simulate the corrosion process of electronic equipment or parts over time. It was developed by the Battelle laboratory in the United States. It is assumed that 48 hours under the above conditions will correspond to four years when stored naturally (which means one day corresponds to two years). The Battelle test can be categorized into 4 different environment classes (Class 1-4), Fujifilm tested under the “Class-2” conditions for 14 days which simulates an office environment without air/temperature/climate control.

For reference, similar testing has been done on BaFe archivability and its stability which was announced by IEEE Transactions on Magnetics Vol 44, No.11, November 2008. It was proven that there was no loss in the output level of recorded signal after storing BaFe tape at high temperature.⁵

Fujifilm will continue to take the lead in the development of BaFe particle which is a proven reliable long term storage solution that will expand the capacity of data storage media in the field of recording media products. This includes the highly functional materials field, which supports the development of advanced data storage systems.

⁵ Reference: M. L. Watson, R. A. Beard, S. M. Keintz, and T. W. Feebeck, "Investigation of Thermal Demagnetization Effects in Data Recorded on Advanced Barium Ferrite Recording Media" IEEE Transaction on Magnetics, vol 44, No. 11, Nov 2008.