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"Data Storage on Fingernail"

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Abstract: - **Recently, there have been rapid developments in the field of information technology, resulting in the need to generate, store, and transport a large amount of information while ensuring data security, an important issue in today's digital age. To meet future demands in information technology, femtosecond laser pulse processing offers a powerful tool for developing new high-capacity devices because it allows fabrication of three-dimensional (3-D) structures inside a wide range of transparent materials. In particular, multilayered 3-D optical bit recording is a promising technique for next-generation computing systems because it offers a large recording capacity by stacking many recording layers without increasing the recording density per layer. Our goal is to realize optical data storage in a human fingernail for highly secure data transportation that does not suffer from problems such as theft, forgery, or loss of recording media.**

I. INTRODUCTION

Recently, there have been rapid developments in the field of information technology, resulting in the need to generate, store, and transport a large amount of information while ensuring data security, an important issue in today's digital age. To meet future demands in information technology, femtosecond laser pulse processing offers a powerful tool for developing new high-capacity devices because it allows fabrication of three-dimensional (3-D) structures inside a wide range of transparent materials. In particular, multilayered 3-D optical bit recording is a promising technique for nextgeneration computing systems because it offers a large recording capacity by stacking many recording layers without increasing the recording density per layer . Our goal is to realize optical data storage in a human fingernail for highly secure data transportation that does not suffer from problems such as theft, forgery, or loss of recording media . Japanese researchers are using femtosecond laser pulses to write data into human fingernails .Secure optical data storage could soon literally be at your fingertips thanks to work being carried out in Japan. Yoshio Hayasaki and his colleagues have discovered that data can be written into a human fingernail by irradiating it with femtosecond laser pulses. Capacities are said to be up to 5 mega bits and the stored data lasts for 6 months - the length of time it takes a fingernail to be completely replaced. (Optics Express 13 4560) Fingernail storage "I don't like carrying around a large number of cards, money and papers," Hayasaki from Tokushima University told Optics.org. "I think that a key application will be personal authentication. Data stored in a fingernail can be used with biometrics, such as fingerprint authentication and intravenous authentication of the finger."

II. BASIC APPROACH

The team's approach is simple: use a femtosecond laser system to write the data into the nail and a fluorescence microscope to read it out. The key to reading the data out is that the nail's fluorescence increases at the point irradiated by the femtosecond pulses. Initial experiments were carried out on a small piece of human fingernail measuring 2 x 2 x 0.4 mm3. The writing system comprises a Ti:Sapphire oscillator and Ti:Sapphire amplifier. Pulses of less than 100 fs at 800 nm are then passed through a microscope and focused to three set depths (40, 60 and 80 microns) using an objective lens. Each "bit" of information has a diameter of 3.1 microns and is written by a single femtosecond pulse. A motorised stage moves the nail to create a bit spacing of 5 microns across the nail and a depth of 20 microns between recording layers. An optical microscope containing a filtered xenon arc lamp excites the fluorescence and reads out the data stored at the various depths. "We regulate the focus with the movement of the microscope objective," explained Hayasaki. "The distance between the planes is set to prevent cross-talk between data stored at different depths. "Hayasaki adds that the same fluorescence signal is seen 172 days after recording. Although the initial experiments have concentrated on small pieces of nail, the team is now developing a system that can write data to a fingernail which

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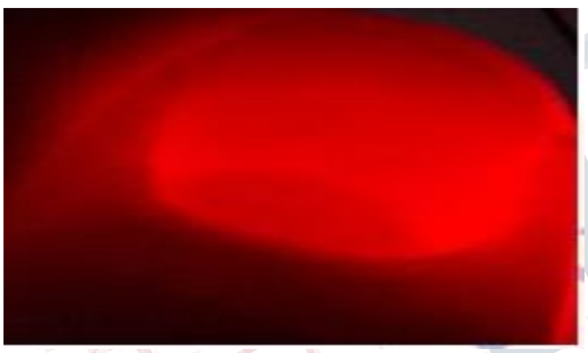
is still attached to a finger. "We will develop a femtosecond laser processing system that can record the data at the desired points with compensation for the movement of a finger," said Hayasaki.

III. DATA ON FINGER NAIL

As technology and science develop, new, more advanced means of storing data are discovered. However, up until know, nobody thought of using the human body as a storage media. According to Jacqueline Hewett for physicsweb.org, Yoshio Hayasaki of Tokushima University and colleagues have discovered that data can be written into a human fingernail by irradiating it with femtosecond laser pulses. Capacities are said to be up to 5 mega bits and the stored data lasts or 6 months, which is the length of time it takes a fingernail to be completely replaced.



"I don't like carrying around a large number of cards, money and papers," says Hayasaki. "I think that a key application will be personal authentication. Data stored in a fingernail can be used with biometrics, such as fingerprint authentication and intravenous authentication of the finger." The team's approach is simple: use a femtosecond (10-15 seconds) laser system to write the data into the nail and a fluorescence microscope to read it out. The key to reading the data out is that the nail's fluorescence increases at the point irradiated by the femtosecond pulses. Initial experiments were carried out on a small piece of human fingernail measuring 2 x 2 x 0.4 cubic millimetres. The writing system comprises a Ti:Sapphire oscillator and Ti:Sapphire amplifier. Pulses of less than 100 femtoseconds at 800 nanometres are then passed through a microscope and focused to three set depths (40, 60 and 80 microns) using an objective lens. Each "bit" of information has a diameter of 3.1 microns and is written by a single femtosecond pulse. A motorised stage moves the nail to create a bit spacing of 5 microns across the nail and a depth of 20 microns between recording layers. An optical microscope containing a filtered xenon arc lamp excites the fluorescence and reads out the data stored at the various depths. "We regulate the focus with the movement of the microscope objective," explains Hayasaki. "The distance When the femtosecond laser pulse is focused inside a material, molecules are subjected to multi-photon ionization and optical field ionization at a local volume where the laser pulse is focused. Consequently, the ionized molecules repulse each other, and a microexplosion occurs, which causes a structural change in the material. By changing the value of Ep data at various layers are stored. The laser ionizes the photon and these photon carry data.
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Although the initial experiments have concentrated on small pieces of nail, the team is now developing a system that can write data to a fingernail which is still attached to a finger. "We will develop a femtosecond laser processing system that can record the data at the desired points with compensation for the movement of a finger," adds Hayasaki.

IV. HOW TO STORE

There is an increase in fluorescence intensity compared with the surrounding auto-fluorescence intensity at a structural change produced by a focused femtosecond laser pulse inside a human fingernail. The spectrum of the increased fluorescence coincides with the auto-fluorescence spectrum of a fingernail and that of pure keratin. The increased fluorescence intensity is also observed in a heated fingernail. It is suggested that the increased fluorescence is a result of a local denaturation of keratin protein caused by the femtosecond laser pulse irradiation. The increased fluorescence effect is very useful for reading out the bit data recorded inside a human fingernail. We also demonstrate that three-dimensionally-arranged structural changes can be read out with little cross-talk by making use of the increased fluorescence. Furthermore, we demonstrate that fluorescence can be observed for up to 6 months, corresponding to the time required for a fingernail to grow from root to tip.

DATA STORING

When the femtosecond laser pulse is focused inside a material, molecules are subjected to multi-photon ionization and optical field ionization at a local volume where the laser pulse is focused. Consequently, the ionized molecules repulse each other, and a microexplosion occurs, which causes a structural change in the material. By changing the

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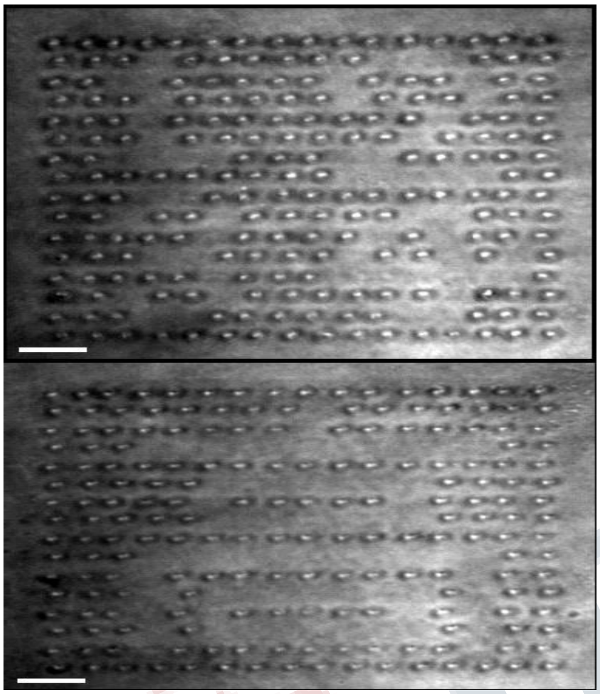
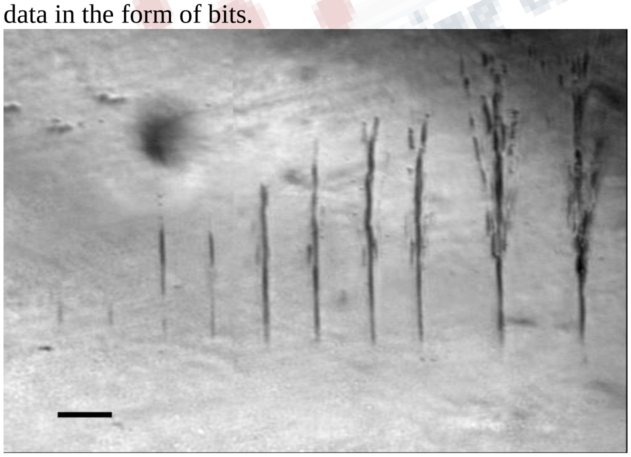
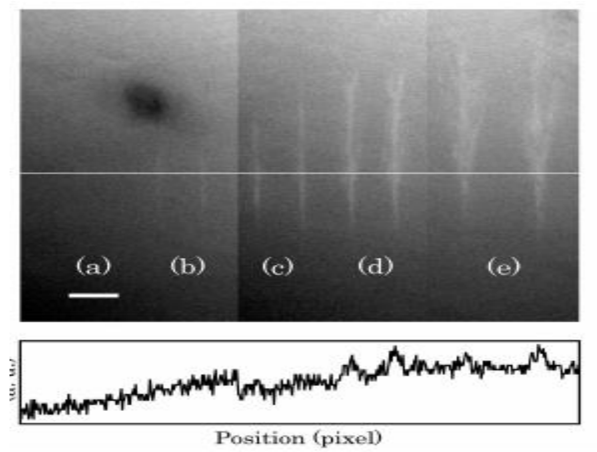


DATA READING

It has been observed that there is an increased fluorescence at the structural changes formed in the fingernail compared with the auto-fluorescence of the fingernail. This change occur due to ionization of molecules . Comparing these changes data can be retrieved. Image taken by microscope is compared with the earlier fluorescence and accordingly a graph is plotted. This graph is further analyse to obtain the data in the form of bits.



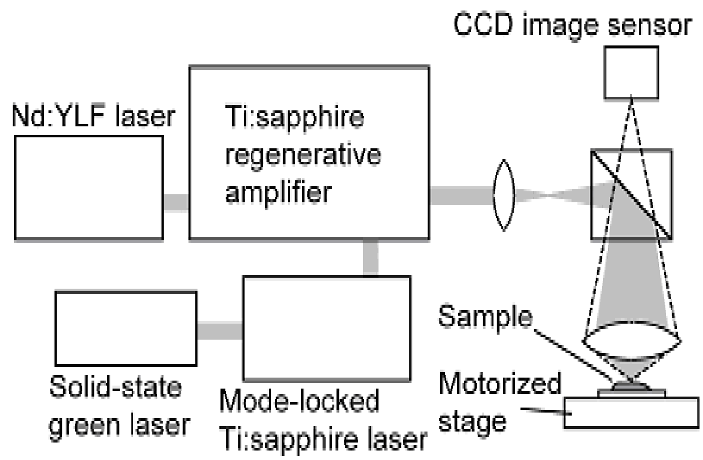


CAPPARATUS USED

1. Femtosecond laser system
2. An optical microscope

A. OTHER PARTS OF HUMAN BODY IN WHICH DATA CAN BE STORED

1. THE LENS OF THE EYE
2. TEETH



V. CONCLUSION

We have demonstrated an increased fluorescence intensity at the structural change inside a human fingernail produced by a focused femtosecond laser pulse. The fluorescence intensity was higher than the surrounding autofluorescence intensity of the fingernail. The structural changes, whose geometrical shape drastically depends on the irradiated pulse energy, are observed as a dark region by using a microscope with transmission illumination. The increased fluorescence intensity was observed in the dark region. The spectrum of the increased fluorescence coincided with the autofluorescence spectra of the fingernail. The increased fluorescence intensity was also observed in a fingernail heated in a drying oven. It is suggested that the increased fluorescence of the structure is a result of a local denaturation the keratin protein caused by heat generated by the femtosecond laser pulse irradiation. We demonstrated that the increased fluorescence of the structure is useful for reading out three-dimensionally recorded data inside a human fingernail. We recorded three bit planes inside a human fingernail. We demonstrated that three bit planes can be read out with little cross-talk by using fluorescence readout. Furthermore, we demonstrated that fluorescence can be observed for up to 6 months, corresponding to the time required for a nail to grow from root to tip. Under these recording conditions, a recording density of 2 Gbit/cm3 is achievable. When the recording performed on an accessible volume of 5 × 5 × 0.1 mm3, the recording capacity of the data is 5 mega bits.

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