

## Structural and Magnetic Properties of Fe<sub>50</sub>Mn<sub>50</sub> Nanocrystalline Alloys

mp. B1.7.16)

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### Introduction

Mechanical Alloying (MA) process is an effective way to fabricate nanocrystalline alloys and their physical properties are related to structural variations.

Some regularity in atomic arrangement in solids can be classified by the short-range order (SRO) and long-range order (LRO). Among these, LRO is frequently examined by X-ray diffraction studies while SRO could be examined by extended X ray absorption fine structure (EXAFS).

Fe-Mn alloys have been studied extensively for many applications in electromagnetic devices, such as magnetic sensors and spin-valve reading/recording heads

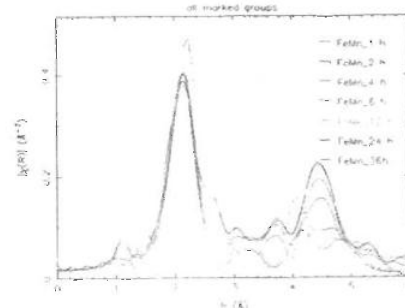
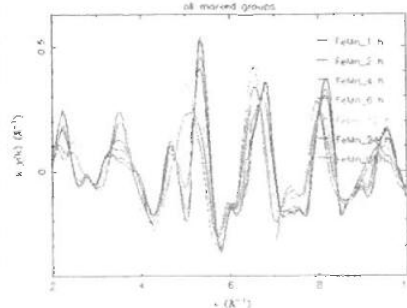
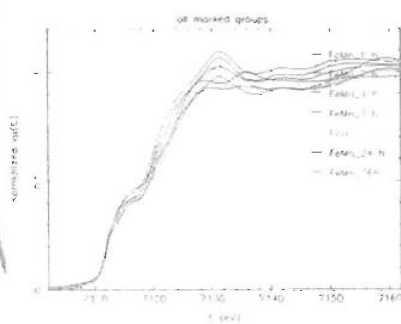
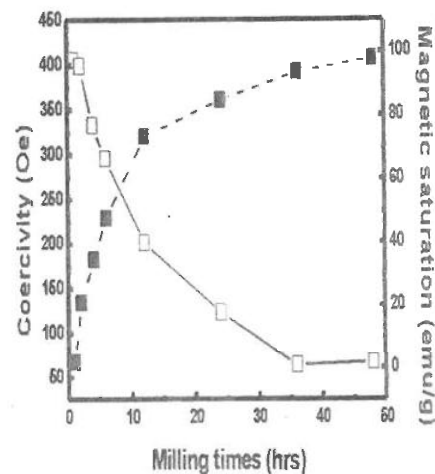
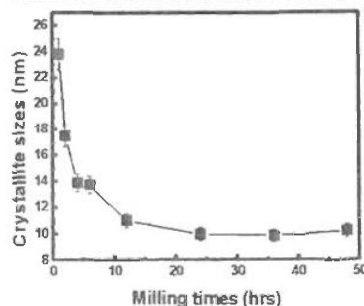
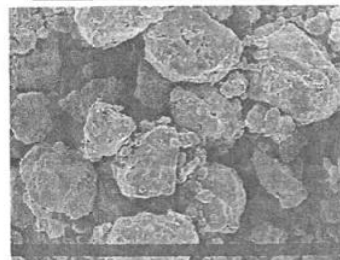
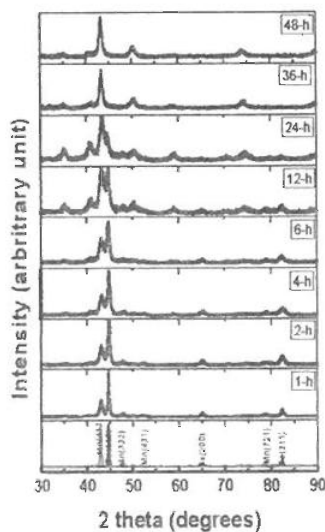
In this work, we present preparation and characterization of the structure and magnetic behavior of Fe<sub>50</sub>Mn<sub>50</sub> alloys as changing the milling time.

### Experiment

Fe<sub>50</sub>Mn<sub>50</sub> metastable alloys were prepared by MA. The starting material was a mixture of pure Fe and Mn powders (used commercial Fe and Mn powders as the precursors). The weight ratio of balls-to-powder mixture was 5:1. Fe<sub>50</sub>Mn<sub>50</sub> alloys were mixed and ground for different times of 1, 2, 4, 6, 12, and 24 hrs in Ar ambient to prevent oxidation during the alloying process.

Magnetic measurements were carried out on SQUID. XRD using the Cu-K<sub>α</sub> radiation. Based on these data, crystallite size estimated with Scherrer formula. EXAFS data were operated with an energy of 2.5 GeV, and a maximum current of 200 mA. EXAFS spectra were obtained at Fe K-edge (7112 eV) in the transmission mode at room temperature. The sample chamber was filled with pure nitrogen gas. The EXAFS data were analyzed by FEFF software. Finally, the nanoparticle size and their shape were checked by SEM.

### Results and discussions



### Conclusions

The formation of Fe<sub>50</sub>Mn<sub>50</sub> metastable alloys is explicitly shown in the EXAFS spectra by the variation of amplitude and phase between 12 hrs and 24 hrs milling times. The significant change of the structural phase revealed that new atom neighbors between the central Fe and Mn atoms increased during the MA process. The Fe and Mn atoms are diffused each other to form the FeMn alloy phase.

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## General Information

### SCOPE OF THE CONFERENCE

The 11th Joint MMM/Intermag Conference is sponsored jointly by the American Institute of Physics (AIP) and the Magnetics Society of the IEEE, in cooperation with The American Physical Society. Members of the international scientific and engineering communities interested in recent developments in fundamental and applied magnetism are invited to attend the Conference and contribute to its technical sessions. Sessions will include invited and contributed papers, oral and poster presentations and invited symposia. This Conference provides an outstanding opportunity for participants to meet their colleagues and discuss new, advanced and controversial developments.

### WASHINGTON, DC

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## CONFERENCE PROGRAM

Mon eve 7:00 p.m.	XA	Magnetization switching below the Stoner-Wohlfarth limit	Salon 2
Tuesday 9:00 a.m.	AA	Symposium: Spin torque devices for CMOS-integrated applications	Salon 2
	AB	Magnetization dynamics and damping I	Salon 3
	AC	Giant magnetoresistance I	Delaware
	AD	Recording physics and measurements	Virginia
	AE	Superconductivity I	Washington 1
	AF	Magnetoresistive oxides: Phase behavior and ordering	Washington 2
	AG	Magnetic sensors I (Not magnetic recording)	Washington 3
	AH	Biosensing and MRI	Washington 5
8:00 a.m.	AP	Bulk magnetoresistive oxides	Exhibit Hall C
	AQ	Magnetoresistive oxide thin films	Exhibit Hall C
	AR	Spin current and spin Hall effect	Exhibit Hall C
	AS	Amorphous and nanocrystalline soft magnets I	Exhibit Hall C
	AT	Magnetocaloric materials I	Exhibit Hall C
	AU	Magnetocaloric materials II	Exhibit Hall C
	AV	Hard magnets: RTM5 and Co-based magnets	Exhibit Hall C
	AW	Hard magnets: FePt	Exhibit Hall C
	AX	Nanoparticles and nanowires	Exhibit Hall C
	AY	Nanoparticles I	Exhibit Hall C
2:00 p.m.	BA	Spin-torque devices: Dynamics and advanced materials	Salon 2
	BB	Energy assisted magnetic recording	Salon 3
	BC	Magnetic microscopy I	Delaware
	BD	Exchange bias I	Virginia
	BE	Spin injection in semiconductors	Washington 1
	BF	Multiferroics: Novel materials	Washington 2
	BG	Magnetoclastic materials I	Washington 3
	BH	Hard magnets: R1TM5 and FePt	Washington 5
1:00 p.m.	BP	Multiferroics: Thin films and composites	Exhibit Hall C
	BQ	Multiferroics: Bulk and nanomaterials	Exhibit Hall C
	BR	Ultrathin films and surface effects I	Exhibit Hall C
	BS	New magnetic materials I	Exhibit Hall C
	BT	Magnetoelastic materials II	Exhibit Hall C
	BU	Magneto-optic microwave and molecular magnet materials	Exhibit Hall C
	BV	Ferrite magnets I	Exhibit Hall C
	BW	Ferrite magnets II	Exhibit Hall C
	BX	Crystalline soft magnets and domains I	Exhibit Hall C
	BY	New applications	Exhibit Hall C
7:00 p.m.	BZ	Symposium: Large scale facilities for magnetism research	Salon 2

Wednesday 9:00 a.m.	CA	Spin-torque devices: Perpendicular	Salon 2
	CB	Multiferroics: Thin films and tunnel junctions	Salon 3
	CC	CPP-GMR reader technology	Delaware
	CD	Symposium: Spin injection into nonmagnetic media	Virginia
	CE	Ferrite magnets III	Washington 1
	CF	Micromagnetics and hysteresis modeling I	Washington 2
	CG	Patterned films I	Washington 3
	CH	Hyperthermia and other applications of nanoparticles	Washington 5
8:00 a.m.	CP	Electrical machines and levitation	Exhibit Hall C
	CQ	Special machines and actuators	Exhibit Hall C
	CR	Linear machines and actuators	Exhibit Hall C
	CS	PM machines I	Exhibit Hall C
	CT	PM machines II	Exhibit Hall C
	CU	Reluctance machines	Exhibit Hall C
	CV	Head-disk interface and integration	Exhibit Hall C
	CW	Magnetic recording - FePt media	Exhibit Hall C
	CX	Magnetic recording: Continuous granular media	Exhibit Hall C
	CY	Bit patterned media I	Exhibit Hall C
	1:30 p.m.	DA	MRAM and Spin-Torque Switches
DB		Ultrafast Dynamics	Salon 3
DC		Symposium: Advanced motor and actuator technologies	Delaware
DD		Symposium: Spin-Calorics	Virginia
DE		Correlated Electron Materials I	Washington 1
DF		Magneto-Optic and Microwave Materials	Washington 2
DG		Inductive Write Heads	Washington 3
DH		Nanoparticles II	Washington 5
1:00 p.m.	DP	Micromagnetics and Hysteresis Modeling II	Exhibit Hall C
	DQ	Hard Magnets: Theory and Oxides	Exhibit Hall C
	DR	Giant Magnetoresistance II	Exhibit Hall C
	DS	Spin Injection in Semiconductors: Organic and Granular Spin-Valves	Exhibit Hall C
	DT	MRAM and Giant Magnetoresistance	Exhibit Hall C
	DU	Magnetic Multilayers	Exhibit Hall C
	DV	Patterned Films II	Exhibit Hall C
	DW	Exchange bias II	Exhibit Hall C
4:00pm	DX	Exchange bias III	Exhibit Hall C
	DZ	Plenary session: Electronic Holography Imaging	Salon 2 and 3

Thursday 9:00 a.m.	EA	Spin-torque Devices: Oscillators Dynamics	Salon 2	
	EB	Symposium: Recent Advances in Microscopy of Magnetic Materials	Salon 3	
	EC	Magnetization Dynamics & Damping II	Delaware	
	ED	Magnetic Recording: Continuous Granular Media	Virginia	
	EE	Electronic Structure and Low Dimensionality Systems I	Washington 1	
	EF	Spin Currents, Spin Hall Effects and Tunnel Magnetoresistance	Washington 2	
	EG	MEMS, High Frequency Devices and Shielding	Washington 3	
	EH	Nanoparticle Composites	Washington 5	
8:00 a.m.	EP	Other Half Metals I	Exhibit Hall C	
	EQ	Magneto-electronic Materials and Effects	Exhibit Hall C	
	ER	Magnetic Semiconductors: Oxides and Other Materials	Exhibit Hall C	
	ES	Magnetic Semiconductors: ZnO	Exhibit Hall C	
	ET	Tunnel Magnetoresistance I	Exhibit Hall C	
	EU	Tunnel Magnetoresistance II	Exhibit Hall C	
	EV	Tunnel Magnetoresistance III	Exhibit Hall C	
	EW	Domain Wall Devices and Spin Transfer Torque	Exhibit Hall C	
	EX	Domain Wall Devices I	Exhibit Hall C	
	EY	Spin-torque Devices: Oscillators and Dynamics	Exhibit Hall C	
	2:00 p.m.	FA	Domain Wall Dynamics	Salon 2
FB		Tunnel Magnetoresistance IV	Salon 3	
FC		Symposium: Magnetic Medical Imaging Technology	Delaware	
FD		Bit-Patterned Media II	Virginia	
FE		Amorphous and Nanocrystalline Soft Magnets II	Washington 1	
FF		Magnetic Semiconductors: III-V	Washington 2	
FG		New Magnetic Materials II	Washington 3	
FH		Critical phenomena, Spin Glasses and Frustration I	Washington 5	
1:00 p.m.		FP	Superconductivity II	Exhibit Hall C
		FQ	Correlated Electron Materials II	Exhibit Hall C
		FR	Electronic Structure and Low Dimensionality Systems II	Exhibit Hall C
	FS	Domain Wall Dynamics & Ultrafast Switching	Exhibit Hall C	
	FT	Magnetization Dynamics and Damping III	Exhibit Hall C	
	FU	Dynamics in Microstructures	Exhibit Hall C	
	FV	Spin-Torque Junctions and Materials	Exhibit Hall C	
	FW	Magnetic Sensors II (not Magnetic Recording)	Exhibit Hall C	
	FX	MEMS and High frequency Devices	Exhibit Hall C	
	7:00 p.m.	FZ	Symposium: Magnetism on the International Technology Roadmap for Semiconductors	Salon 2

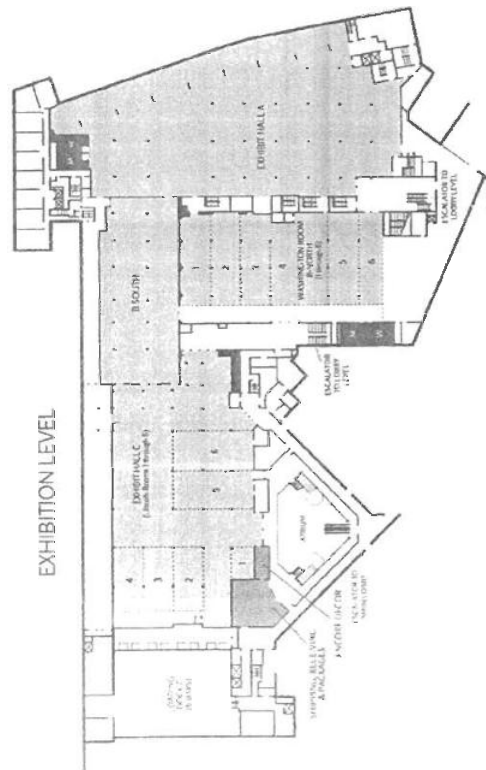
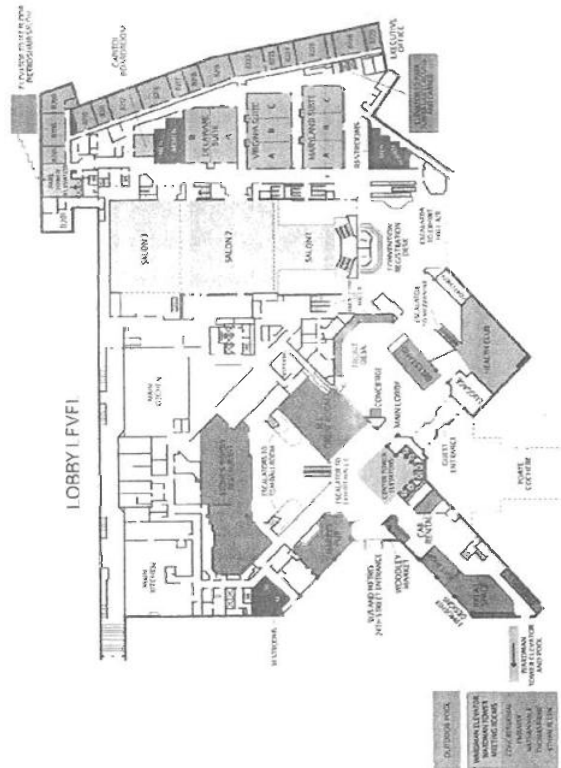
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Friday  
9:00 a.m.

GA	Domain Wall Devices II	Salon 2
GB	Symposium: Emergent phenomena in magnetic complex oxides in reduced dimensionality	Salon 3
GC	Magnetic Microscopy II	Delaware
GD	Vortex Dynamics	Virginia
GE	Ultra Thin Films and Surface Effects II	Washington 1
GF	Magnetic Semiconductors: Oxides	Washington 2
GG	Motors and Actuators	Washington 3
GH	Channel and Signal Processing	Washington 5
GP	Hard Magnets I: R2Fe14B	Exhibit Hall C
GQ	Critical Phenomena, Spin glasses and Frustration	Exhibit Hall C
GR	Nanoparticles for biomedicine	Exhibit Hall C
GS	Biomedical Applications	Exhibit Hall C
GT	Magnetic Fluids and Separation	Exhibit Hall C
GU	Instrumentation and Measurement techniques	Exhibit Hall C
GV	Machine Modelling and Analysis	Exhibit Hall C
GW	Power and Control Magnetics	Exhibit Hall C
GX	EMI and Computational Electromagnetics	Exhibit Hall C
GY	Magnetic Microscopy III	Exhibit Hall C

2:00 p.m.

HA	Symposium: Competitive Memory and Storage Technologies	Salon 2
HB	Spin Injection in Metals: Spin-Torque	Salon 3
HC	Magnetic multilayers and thin films	Delaware
HD	Transformers and Inductors	Virginia
HE	Crystalline Soft Magnets and Domains II	Washington 1
HF	Hard Magnets II: R2Fe14	Washington 2
HG	Magnetocaloric materials III	Washington 3
HH	Other half metals II	Washington 4



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## PROGRAM

- BW-15. **An external field applied  $MFe_2O_4$  (M=Mn, Mg) nanoparticles with Mössbauer spectroscopy.** S. Hyun<sup>1</sup>, I. Shim<sup>1</sup> and C. Kim<sup>1</sup>  
1. *Physic. Kookmin University, SEOUL, Korea, Republic of*

TUESDAY  
AFTERNOON  
1:00

EXHIBIT HALL C

**Session BX**  
**CRYSTALLINE SOFT MAGNETS AND**  
**DOMAINS I**  
**(POSTER SESSION)**

Hans Gatzen, Chair

- BX-01. **Non-contact evaluation of surface modified materials by a model-assisted hysteresis measurement technique.** C. Lo<sup>1</sup>  
*Center for MDE, Iowa State University, Ames, IA*
- BX-02. **Multiple phase transformation and resultant magnetic properties in  $Fe_3Pt$  thin films.** S. Hsiao<sup>1</sup>, S. Chen<sup>1</sup> and H. Lee<sup>2</sup>  
*Materials Science and Engineering, Feng Chia University, Taichung, Taiwan; 2. National Synchrotron Radiation Research Center, Hsinchiu, Taiwan*
- BX-03. **Preparation and structural characterization of FeCo epitaxial thin films on insulating single-crystal substrates.**  
T. Nishiyama<sup>1</sup>, M. Ohtake<sup>1</sup>, F. Kirino<sup>2</sup> and M. Futamoto<sup>1</sup>  
*1. Faculty of Science and Engineering, Chuo University, Tokyo, Japan; 2. Graduate School of Fine Arts, Tokyo National University of Fine Arts and Music, Tokyo, Japan*
- BX-04. **Change of magnetic properties of a Cold Rolled and Thermally Aged Fe-Cu Alloy.** D.G. Park<sup>1</sup>, C.S. Angani<sup>1,4</sup>, K.S. Ryu<sup>2</sup>, S. Kobayashi<sup>3</sup> and S. Takahashi<sup>3</sup>  
*1. Nuclear Materials Research Division, Korea Atomic Energy Research Institute (KAERI), Daejeon, Korea, Republic of; 2. Korea Research Institute of Standard Science (KRISS), Daejeon, Korea, Republic of; 3. NDE and Science Research Center, Iwate University, Morioka, Japan; 4. Department of Materials science Engineering, Chungnam National University(CNU), Daejeon, Korea, Republic of*
- BX-05. **Comparison of soft magnetic properties of permalloy and conetic thin films depending on Ta buffer layer.** S. Lee<sup>1,2</sup>, J. Choi<sup>1,2</sup>, D. Hwang<sup>1,2</sup> and J. Rhee<sup>3</sup>  
*1. Oriental Biomedical Engineering, Sangji University, Wonju, Gangwon-do, Korea, Republic of; 2. Eastern-western Biomedical Engineering, Sangji University, Wonju, Gangwondo, Korea, Republic of; 3. Physics, Sookmyung Women's University, Seoul, Seoul, Korea, Republic of*

→ **BX-14. Structural and magnetic properties of Fe<sub>50</sub>Mn<sub>50</sub> nanocrystalline alloys.** K. Tarigan<sup>1</sup>, Y. Dong Seok<sup>2</sup>, Kwang-Kwyun<sup>1</sup>, Suhk Kun<sup>1</sup> and Seong Cho<sup>1</sup>. *1. Physics, Chungbuk National University, Cheongju, Chungbuk, Korea, Republic of; 2. Physics Division, School of Science Education, Chungbuk National University, Cheongju, Chungbuk, Korea, Republic of*

**BX-15. Improvement of high-frequency characteristics by pinning effect of thin Cr interlayers in FeCoTa films.** S. Li<sup>1,2</sup>, J. Duh<sup>3</sup>, S. Tsai<sup>4</sup>, Z. Tian<sup>5</sup> and J. Liu<sup>6</sup>. *1. Department of Physics, Fujian Normal University, Fuzhou, China; 2. National Laboratory of Solid State Microstructure, Nanjing University, Nanjing, China; 3. Department of Materials Science and Engineering, National Tsing Hua University, Hsinchu, Taiwan; 4. EPMA Lab, Precision Instrument Center, National Tsing Hua University, Hsinchu, Taiwan; 5. College of Mechanical and Electrical Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing, China; 6. Department of Physics, University of Texas at Arlington, Arlington, TX*

**BX-16. Crystalline analysis of Permalloy narrow wires subject to current pulses.** Y. Togawa<sup>1,2</sup>, T. Kimura<sup>2,3</sup>, K. Harada<sup>2,4</sup>, T. Akashi<sup>5</sup>, A. Tonomura<sup>3,4</sup>, S. Mori<sup>1</sup> and Y. Otani<sup>2,3</sup>. *1. Nanoscience and Nanotechnology Research Center, Osaka Prefecture University, Sakai, Osaka, Japan; 2. Advanced Science Institute, Institute of Physical and Chemical Research (RIKEN), Wako, Saitama, Japan; 3. Institute for Solid State Physics, University of Tokyo, Kashiwa, Chiba, Japan; 4. Advanced Research Laboratory, Hitachi, Ltd., Hatoyama, Saitama, Japan; 5. Hitachi High-Technologies Co., Hitachinaka, Ibaraki, Japan*

TUESDAY  
AFTERNOON  
1:00

EXHIBIT HALL C

**Session BY  
NEW APPLICATIONS  
(POSTER SESSION)**

Jin-Wei Tioh, Chair

- BY-01. Current-controlled, high-speed magneto-optic switching.**  
S. Kemmet<sup>1</sup>, M. Mina<sup>1</sup> and R.J. Weber<sup>1</sup>. *1. Electrical and Computer Engineering, Iowa State University, Ames, IA*
- BY-02. All-optical Integrated Switch Utilizing Faraday Rotation.**  
J. Tioh<sup>1</sup>, M. Mina<sup>1</sup> and R.J. Weber<sup>1</sup>. *1. Iowa State University, Ames, IA*
- BY-03. Withdrawn**
- BY-04. Novel solder-magnetic particle composites, their reflow using AC magnetic fields.** A.H. Habib<sup>1</sup>, M.G. Ondeck<sup>1</sup>, K.J. Miller<sup>1</sup>, R. Swaminathan<sup>2</sup> and M.E. McHenry<sup>1</sup>. *1. Materials Sc. and Engg., Carnegie Mellon University, Pittsburgh, PA; 2. Intel Corp., Chandler, AZ*

## PROGRAM

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