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# Chemical solution deposition of $Y_1Ba_2Cu_3O_{7-x}$ thin films on $SrTiO_3$ substrates


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## Abstract


Conventionally the fabrication of superconducting thin films is carried out by tedious processes and requires expensive equipment. Here we report the growth of $YBa_2Cu_3O_{7-x}$ (YBCO) thin films on $SrTiO_3$ substrates by the low-cost chemical solution deposition technique [1]. The preparation includes the precipitation of yttrium, barium and copper acetates in oxalic acid; and directly dripping onto $SrTiO_3$ ([100] orientation) substrates. The epitaxial growth of the deposited layer was carried out by calcination and thermal treatments at 840 and 860 ℃. The surface morphology was inspected by optical microscopy. X-ray diffraction (XRD) confirms the preferential epitaxial growth (00l) of the YBCO crystallites, especially after thermal treatment at 860 ℃. Both samples show a superconducting critical temperature of 90 K. The estimation of the critical current density ($Jc$) of the samples was measured indirectly from their respective hysteresis cycles following the Bean equation [2] at 10 K. For the sample treated at 840 ℃, $Jc$ was 19 x $10^4$ A/cm², while for the sample obtained at 860 ℃ $Jc$ was 17 x $10^9$ A/cm², indicating that a thermal treating of 840 ℃ is enough to obtain a versatile YBCO thin film.

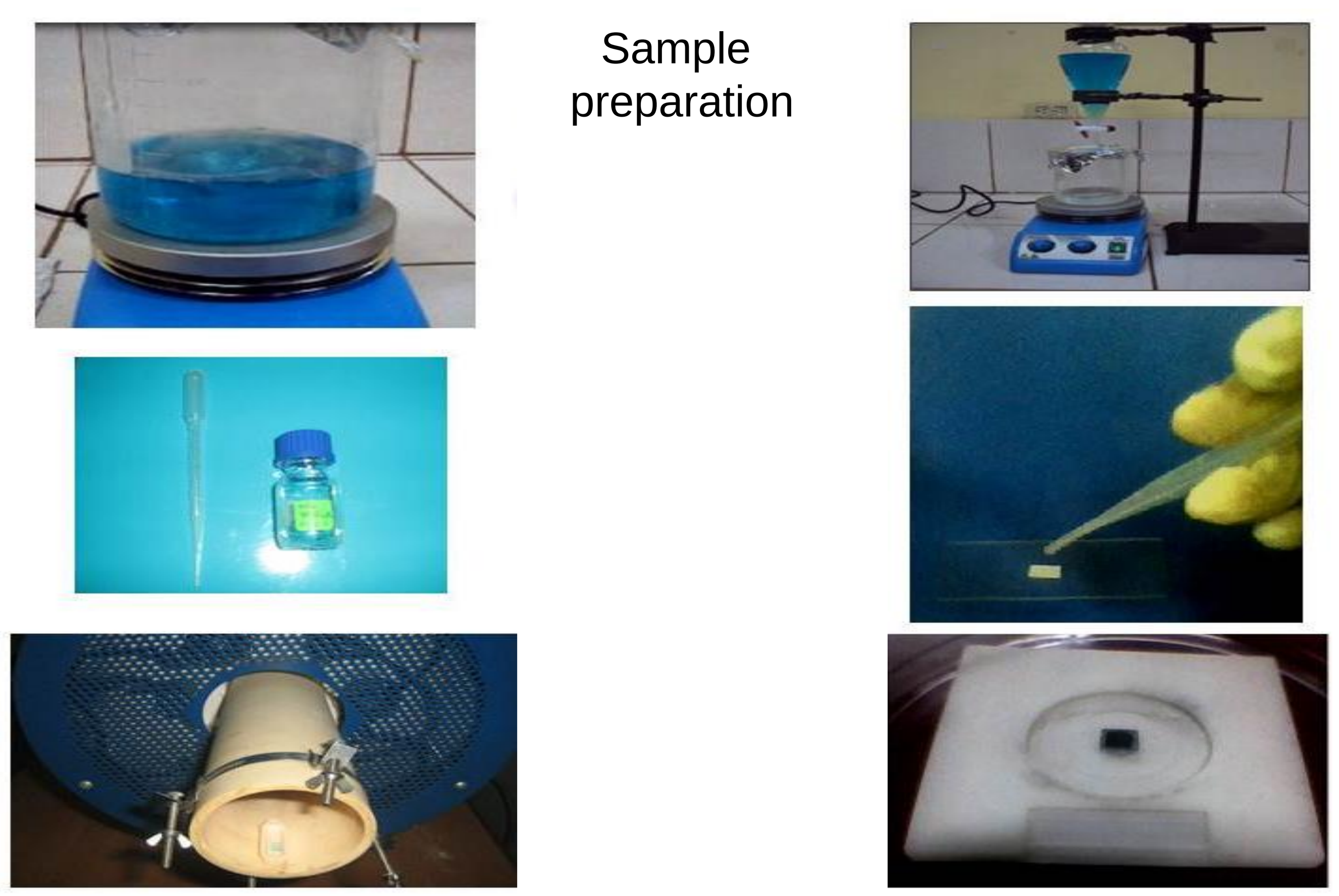

## Methodology

Sample preparation

A.1

A.2

A.3



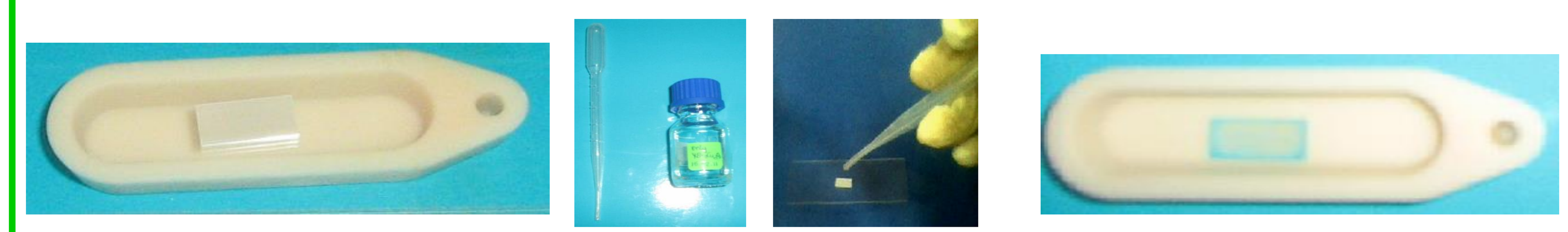
## A.1 Chemical solution

Preparation of the compound (precursor Solution) $YBa_2Cu_3O_7$

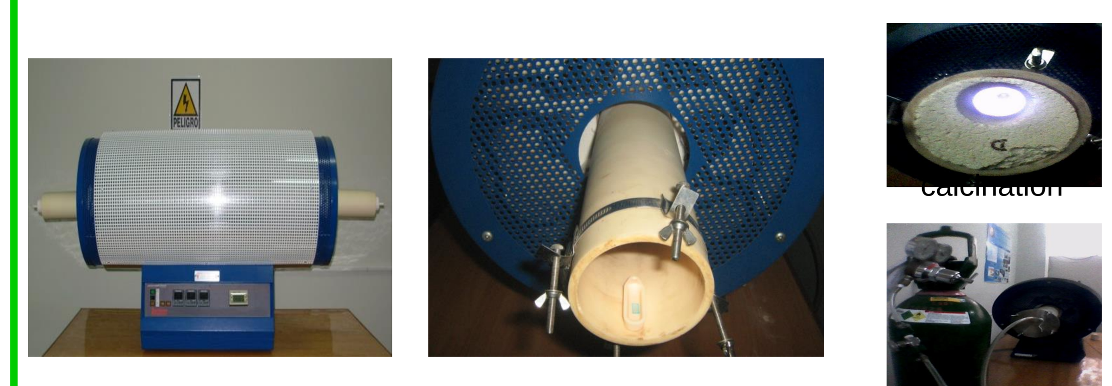
Acetates, for the preparation of 1.5 g precursor

| | |
|---|---|
| (a) $Cu(COOCH_3)_2.1H_2O$ | 0.8991g acetato de Cu |
| (b) $Y(COOCH_3)_3.4H_2O$ | 0.5075 g acetato de Y |
| (c) $Ba(COOCH_3)_2$ | 0.7668 g acetato de Ba |

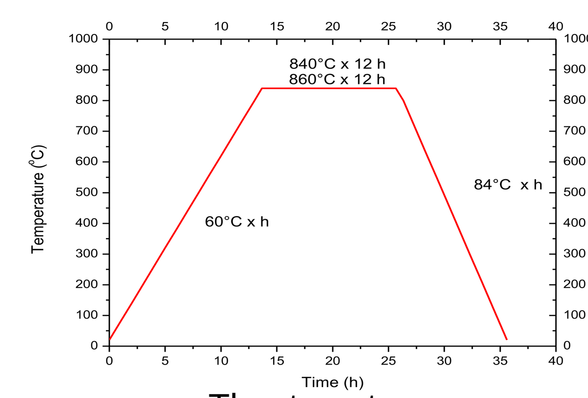
## A.2 Deposition



## A. 3 Thermal treatments



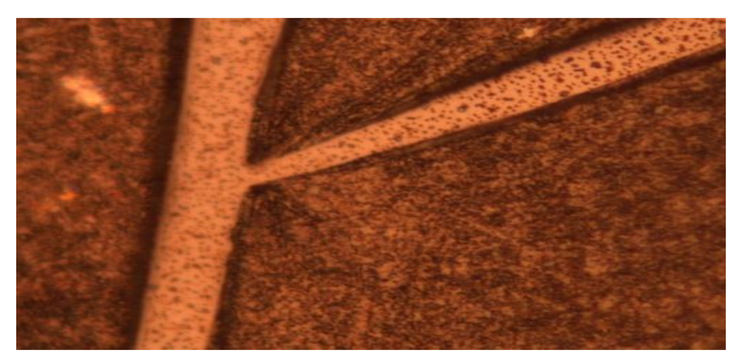
Furmace  Sample in furmace  calcination  sintered




Theatment process

## Analysis Result

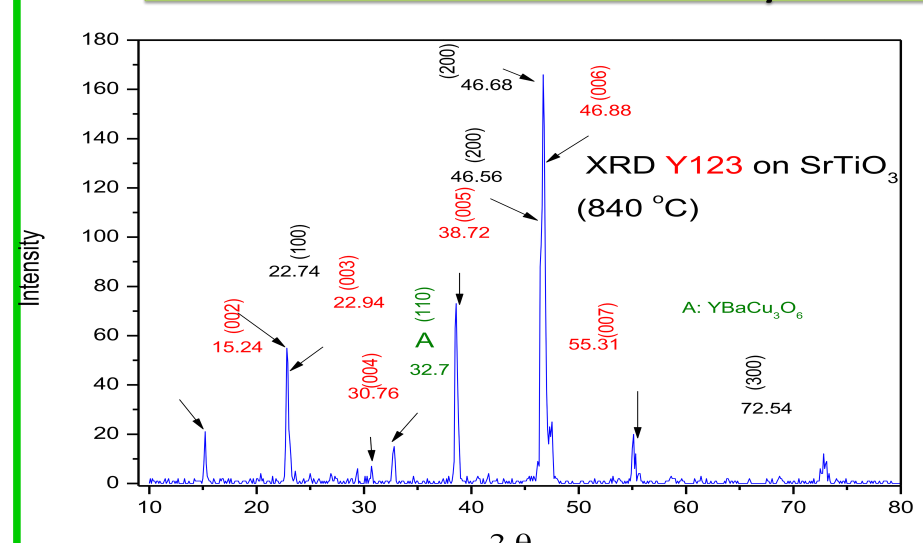
### Optical Microscopy

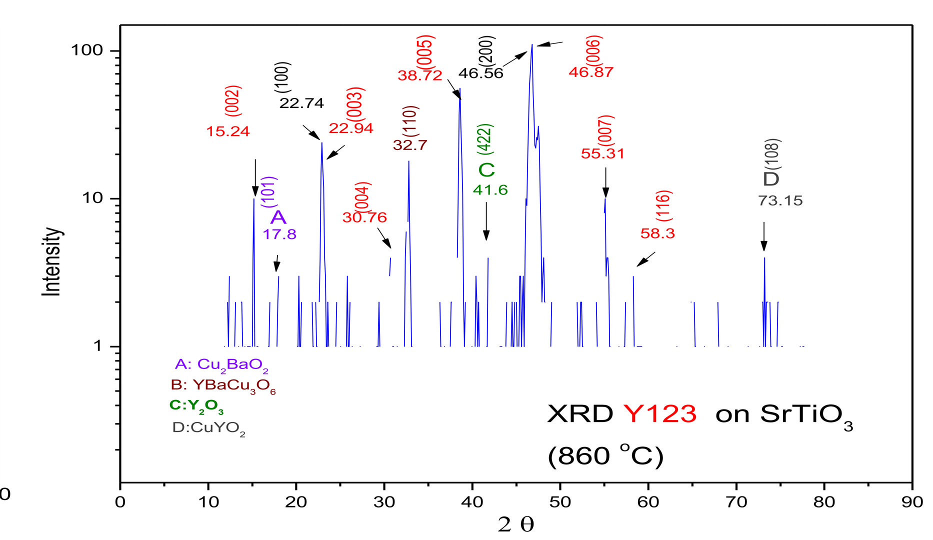


Sample on Sustrate 840 ℃ x100

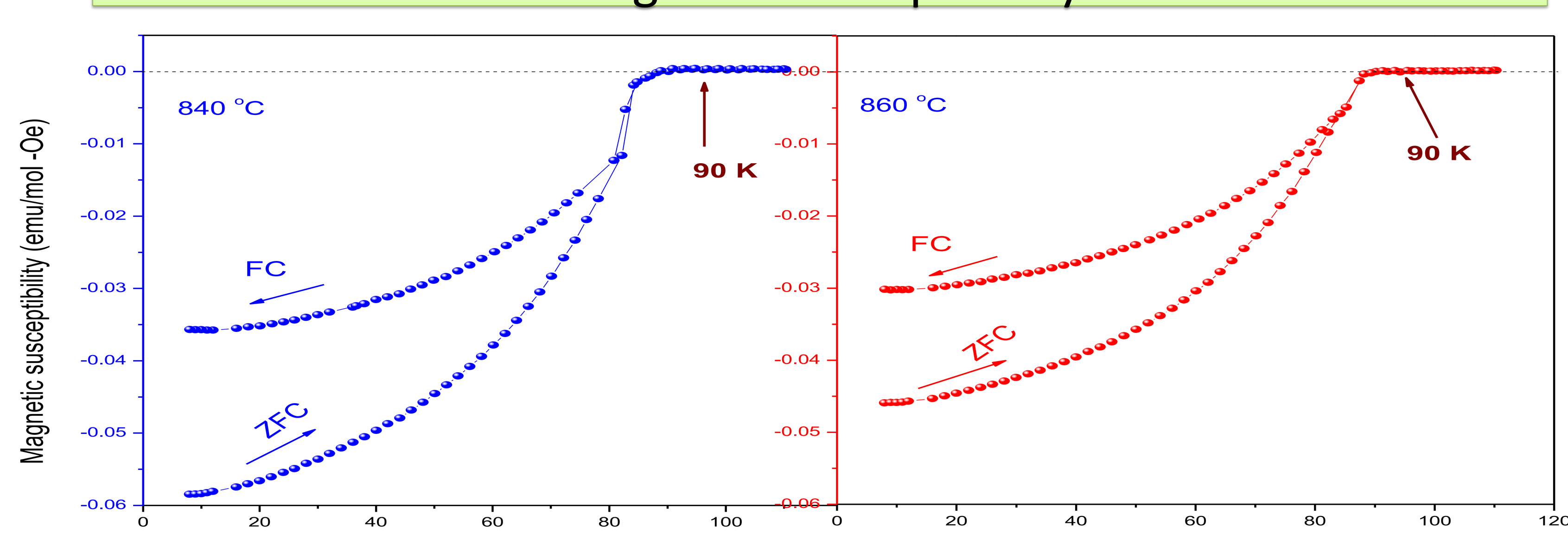
Sample on Sustrate 860 ℃ x100

### X-Ray Diffraction (XRD)



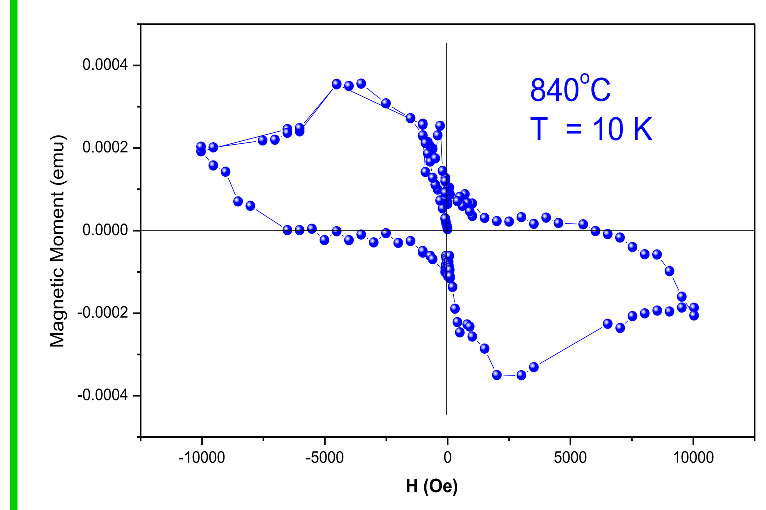




### Magnetic susceptibility

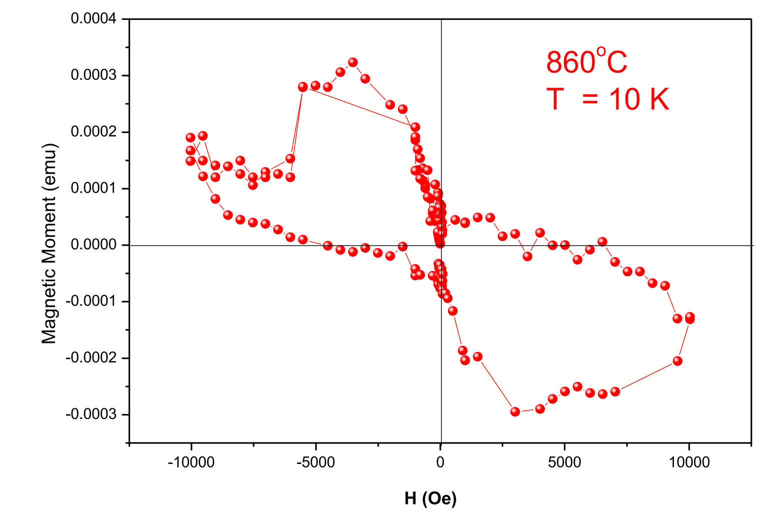



Both samples, 840 ℃ and 860 ℃ show a superconducting critical temperature of 90 K , *Zero Field Cooling* (ZFC) y *Field Cooling* (FC)

## Magnetic Moment




Magnetic moment Vs. H, sample 840 ℃



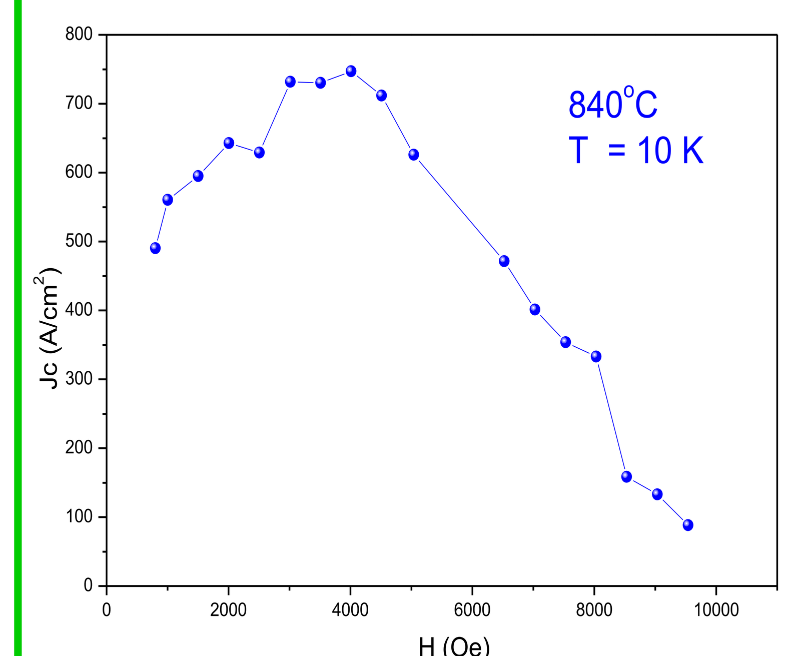

Magnetic moment Vs. H, sample 860 ℃

## Critical Current Density ($Jc$)

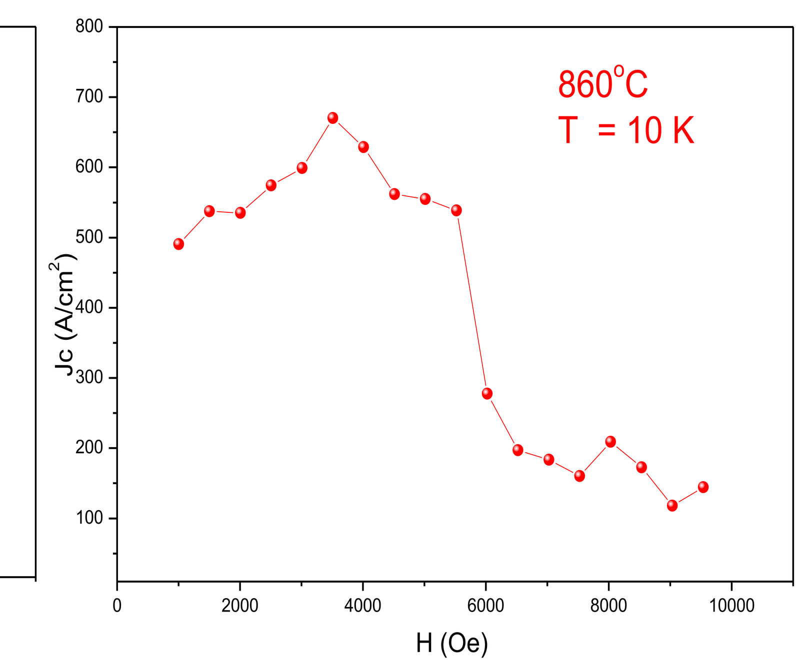
Following the Bean equation [2]

$$Jc = \left[\frac{20\Delta M}{\tau w^2\left(\iota - \frac{w}{3}\right)}\right]$$

where $\Delta M$ is the difference in magnetization values at a particular magnetic field, and $\tau$, $w$, and $\iota$ are the thickness, the width, and the length of the sample, respectively.




Sample treated at 840 ℃
$Jc$ : 19 x $10^4$ A/cm²




Sample obtained at 860 ℃
$Jc$: 17 x $10^9$ A/cm²

## Conclusions

We can manufacture superconducting films at low cost.
The morphological characterization, optical microscopy, indicated that in the sample treated thermally at 860 ℃ is more homogeneous.
The XRD gives the Coexisting with the secondary phases $BaCuO_2$, $Cu_2BaO_2$ and $Y2BaCuO_5$ (green phase).
Magnetic moment graphs Vs temperature, improve as the temperature increases.
A thermal treating of 840 ℃ is enough to obtain a versatile YBCO thin film.

## Referencias


[1] Yuanqing Chen et al. (2016). High Critical Current Density of YBa2Cu3O7−x Superconducting Films Prepared through a DUVassisted Solution Deposition Process. Scientific Reports. DOI: 10.1038/srep38257.

[2] J. Narayan, A. Bhaumik y R. Sachan., Journal of Applied Physics Vol 123 2018 135304.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