HYPERCONDUCTIVITY IN LAYERED SILICATES OF THE MICA GROUP

F. Michael Russell[1], Mark W. Russell[2], Juan F.R. Archilla[3], Santiago Medina-Carrasco[4,*] and María del Mar Orta[5]

[1]*School of Computing and Engineering, University of Huddersfield, HD1 3DH, UK*

[2]*Turbon International Ltd, 130 Abingdon, OX14 2AG, UK*

[3]*Group of Nonlinear Physics, Universidad de Sevilla, ETSII, Avda Reina Mercedes s/n, 41012-Sevilla, Spain*

[4]*X-Ray Laboratory (CITIUS), Universidad de Sevilla, Avda Reina Mercedes 4B, 41012-Sevilla, Spain*

[5]*Department of Analytical Chemistry, Faculty of Pharmacy, Universidad de Sevilla, E-41012, Sevilla, Spain*

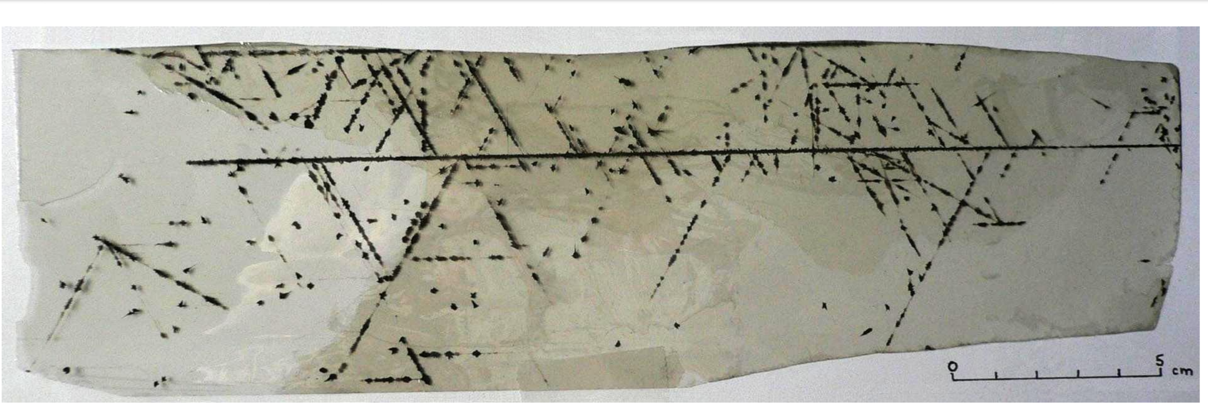
*Corresponding author: **sanmedi@us.es**

INTRODUCTION

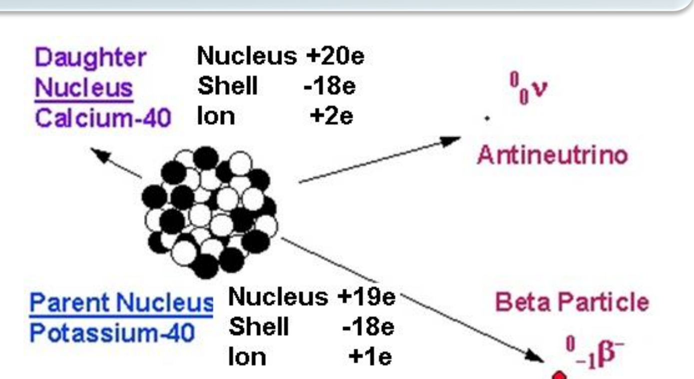
Mica muscovite have been shown to be able to record the passage of swift particles as dark tracks produced by the precipitation of excess iron and grown by accretion. However, they were only a minority among the tracks observed in natural crystals of muscovite. Most of the tracks were along the close packed lines of the potassium layer and lacked the characteristic kinkiness due to Rutherford scattering of swift particles. They were predicted to be produced by energetic packets of energy, called quodons, travelling along the atom chains, It was confirmed experimentally by bombarding an edge of an specimen of muscovite and observing the ejection of an atom at the opposite side along close packed lines [1].

A review of the subject [2] observed that only the tracks of positive particles as protons, positrons and antimuons were recorded. The tracks of swift particles at low velocities were similar in thickness to the quodons, which led to the hypothesis that quodons were also able to carry electric charge. This was confirmed experimentally by measuring the electric currents in absence of an electric field when a specimen of muscovite was filled with quodons produced by alpha bombardment [3]. This phenomenon was called hyperconductivity.

EXPERIMENTAL PART

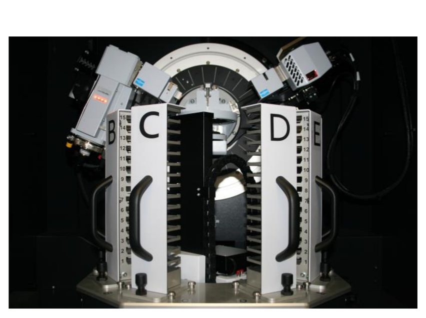


Primary and secondary quodon tracks in mica for ^{40}K decay. Primary ones are produced by when the recoil has the right direction and energy. Secondary ones by scattering



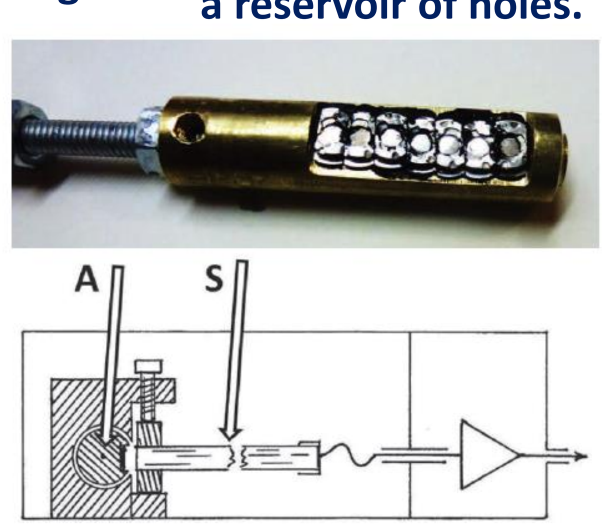
The dominant decay of ^{40}K is β^- with 89% probability . This process produces a reservoir of holes.

CHARACTERIZATION



XRD

XRF



Top: photo of the ^{241}Am alpha-particle source. Bottom: schematic diagram of the experiment.

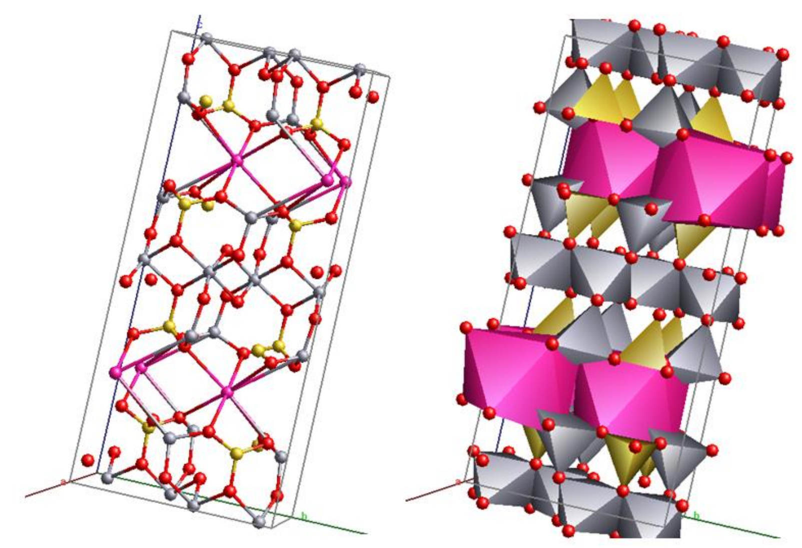
REFERENCES

1. F. M. Russell; J. C. Eilbeck., EPL **2007**, 78, 10004.
2. F. M. Russell, in *Quodons in Mica: Nonlinear Localized Travelling Excitations in Crystals.* J. F. R. Archilla et. al., Ed; Springer, Cham, **2015**;3-33.
3. F. M. Russell; J. F. R. Archilla; F. Frutos; S. Medina-Carrasco, EPL **2017**, 120, 46001.
4. F. M. Russell; M. W. Russell; J. F. R. Archilla, EPL **2019**, 127, 16001

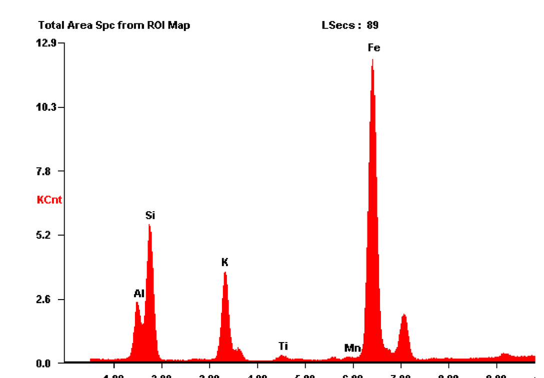
ACKNOWLEDGEMENTS

PRX18/00360 (MICINN,Spain), 2017/FQM-280 (Junta de Andalucia, Spain) and VIPPITUS 2018 (Universidad de Sevilla, Spain).

RESULTS AND DISCUSION



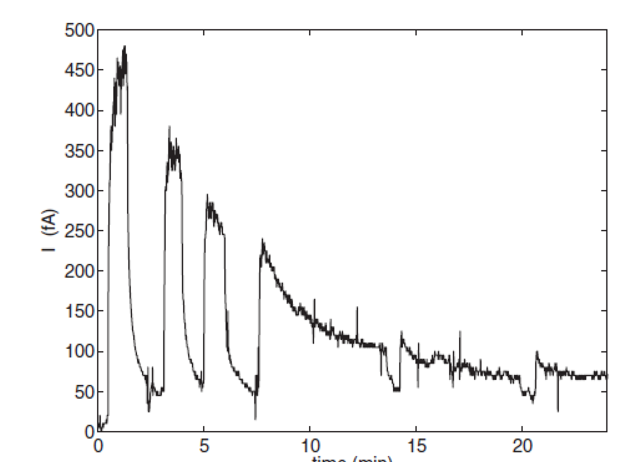
Positions of the atoms in the structure and a representation of the polyhedrons in Mica after XRD adjustment



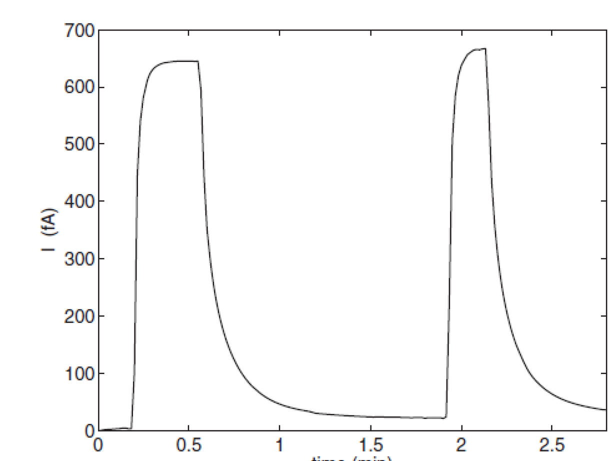
Element	Wt%
Al	26.38
Si	43.10
K	16.59
Ti	00.47
Mn	00.18
Fe	13.29

XRF analysis of samples with tracks

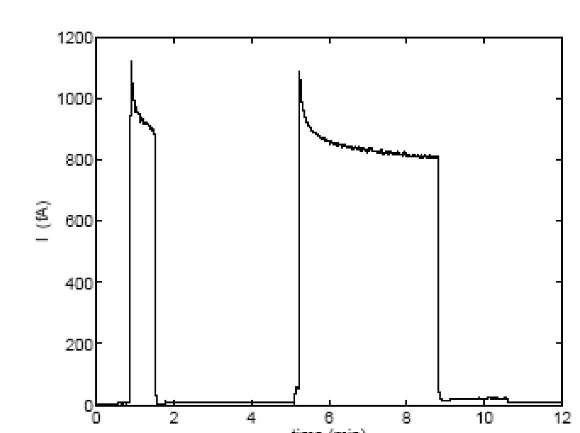
The present work presents experimental results on hyperconductivity in several layered silicates of the mica group: lepidolite, phlogopite and synthetic fluorphlogopite. Other silicates as biotite and quartz were also tested with negative results, showing that the layered structure is a necessary but not sufficient condition.



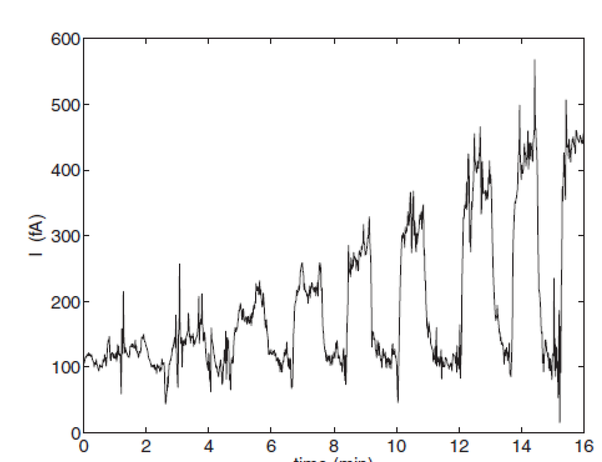
Hyperconductivity current of a previously not irradiated crystal of fluorphlogopite when the alpha irradiation starts and is then interrupted for short intervals.



Hyperconductivity current in a lepidolite crystal of good quality, in a sample previously depleted of holes. The long life of quodons can be observed



Hypercurrent in a hole-depleted sample of bad quality of natural phlogopite. There is no evidence of quodons after the radiation.



Growth of the transmitted hole current as crystal damage is annealed in a crystal of muscovite

CONCLUSIONS

Several new experiments were performed in the previous minerals and also in muscovite [4]. They were able to detect new properties: the hypercurrent flowed a few seconds after irradiation was stopped, proving the long life of nonlinear excitations. The hypercurrent was also able to flow over defects and dislocations and even to anneal some of them. This was demonstrated by joined damaged surfaces and observing the recovery of the hypercurrent after some initial time. It was also shown that the hypercurrent was unaffected by magnetic fields up to one tesla.