Electronic Supplementary Material (ESI) for RSC Advances.

Supplementary Information

Superparamagnetic Iron Oxide Nanoparticles (SPIONs) conjugated with Lipase *Candida Antarctica* A for Biodiesel Synthesis

Luis Fernando Peffi Ferreira,[*a] Thayná Mazzi de Oliveira,[a] Sergio Hiroshi Toma,[b] Marcos Makoto Toyama,[b] Koiti Araki [b] and Luis Humberto Avanzi [c]

[a.] *Chemical Engineering Department, FEI University Center, São Bernardo do Campo, SP, 09850-901, Brasil.*
[b.] *Chemistry Institute, University of São Paulo, SP, 05508-000, Brazil.*
[c.] *Physics Department, FEI University Center, São Bernardo do Campo, SP, 09850-901, Brasil.*
∗ *Corresponding author: Luis Fernando Peffi Ferreira - lpeffi@fei.edu.br.*

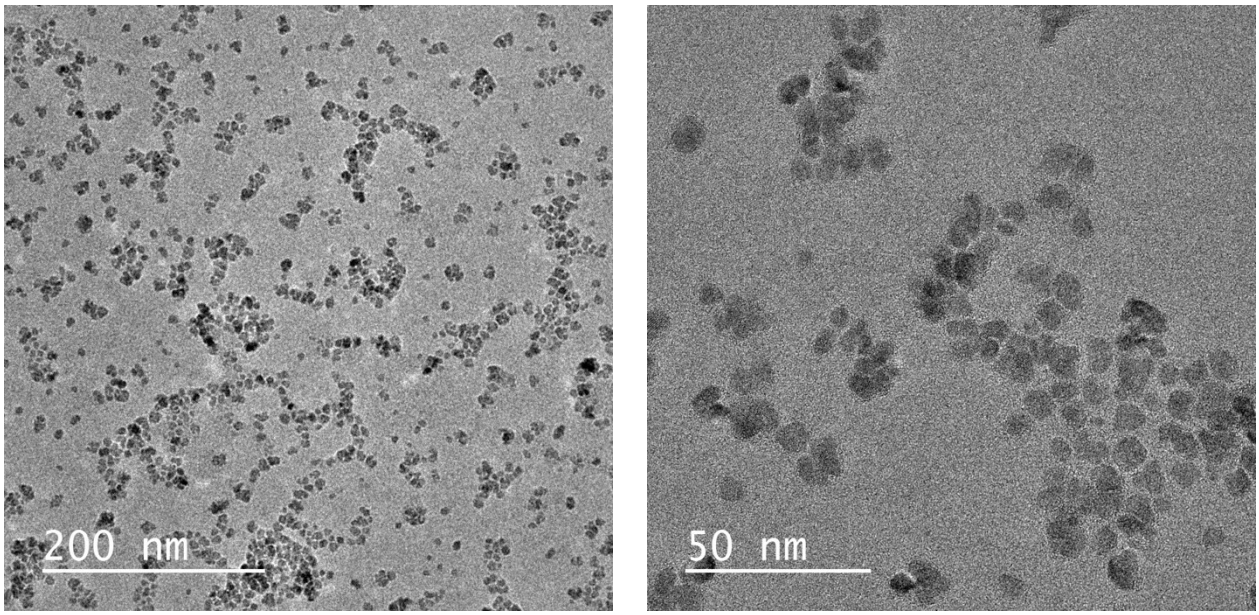


Figure S1. TEM images of SPIONs on copper grid (TedPella).

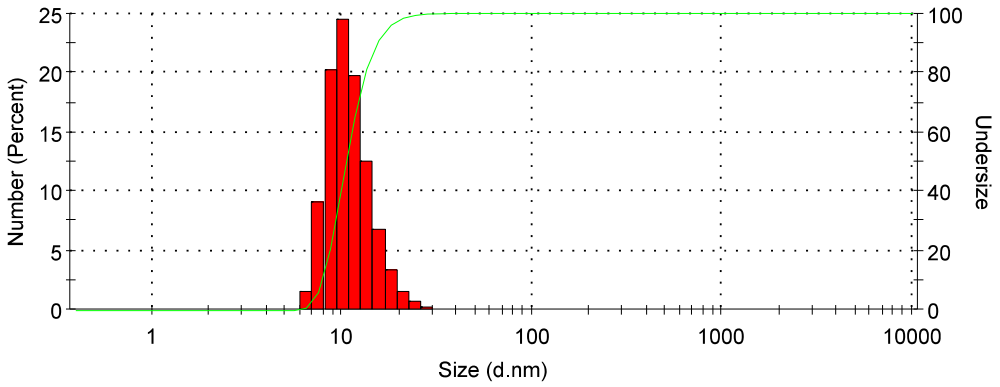


Figure S2. Size distribution of SPIONs dispersion in water measured by DLS.

Table S1. Average size and Zeta potential of SPION and SPION-CAL-A.

Nanomaterial	Average Size (nm)	Zeta Potential (mV)
SPION	**11**	**+10.2**
SPION-CAL-A	**33**	**-25.8**

Biodiesel Composition

Typical biodiesel composition (methyl esters) and retention times in CG-FID and typical chromatogram of biodiesel obtained from soybean oil and methanol (ratio 1: 6), 6 h reaction time and stirring 300 rpm, temperature 60 °C, and 3.0 wt% of catalyst. The average composition in fat acids typical of soybean biodiesel is 11.0% palmitate (16:0), 2.0% stearate (18:0), 20.0% oleate (18:1), 64.0% linoleate (18:2) and 3.0% others.

Table S2: *Typical methyl esters retention times.*

GC parameters for methyl esters		
Methyl Esters	**RT (min)**	**Molar mass (g/mol)**
Laurate	4,916	214.34
Miristate	5,901	242.40
Palmitoleate	6,990	268.44
Palmitate	7,187	270.46
Linolenate	8,526	292.47
Linoleate	8,735	294.47
Oleate	8,819	296.49
Stearate	9,171	298.50

RT= Retention time

Figure S3: Typical gas chromatogram of of a biodiesel sample with a conversion rate of 82-85% using 3.0 wt% of catalyst under the conditions described in the manuscript.

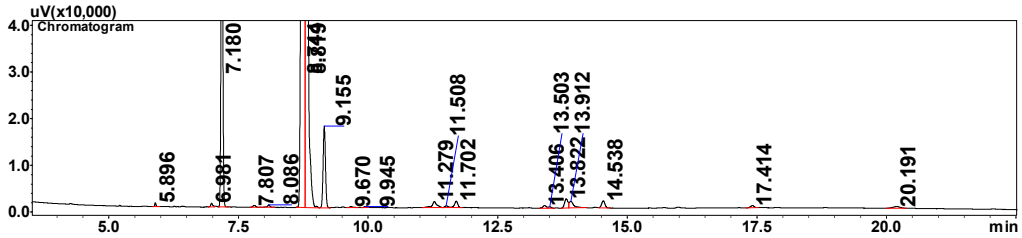
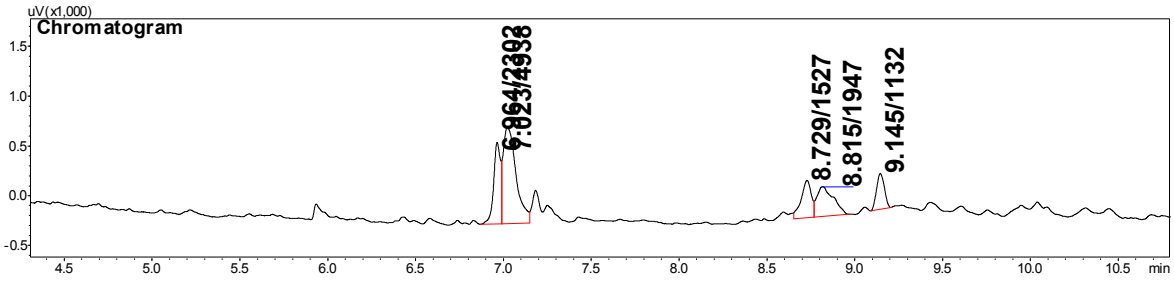


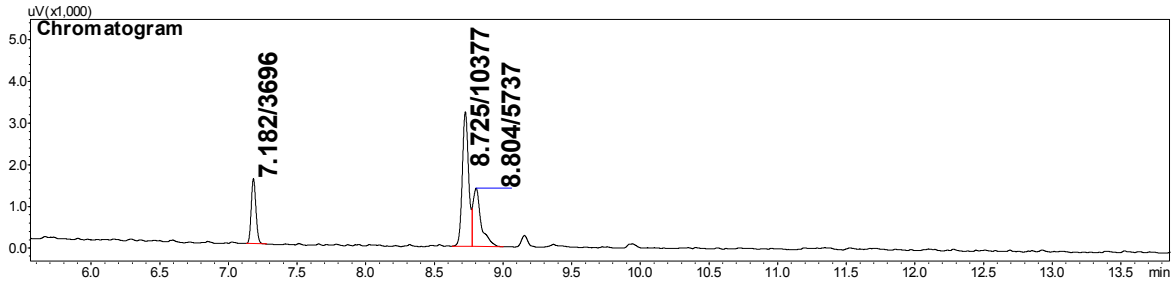
Figure S4:Typical composition of the a biodiesel sample prepared using SPION-CAL-A and Lipozyme 435 (CAL B).

SPIONs-CAL A **biodiesel**

slope **1000 µV/mL**

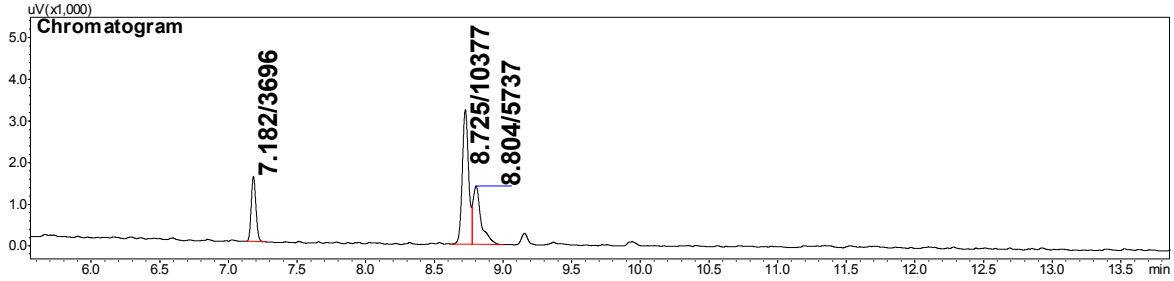


RT (min)	Area
0,513	328966,7
0,559	1,25E+09
0,858	1798,5
1,689	1296,6
1,894	1170,1
6,964	2301,7
7,023	4937,9
8,729	1526,6
8,815	1946,8
9,145	1132,2
29,307	2417,2
36,219	1025,2



Lipozyme 435

slope **1000 µV/mL**



Reference:

1- Dennis Y.C. Leung *, Xuan Wu, M.K.H. Leung, A review on biodiesel production using catalyzed transesterification; Applied Energy 87 (2010) 1083–1095.