

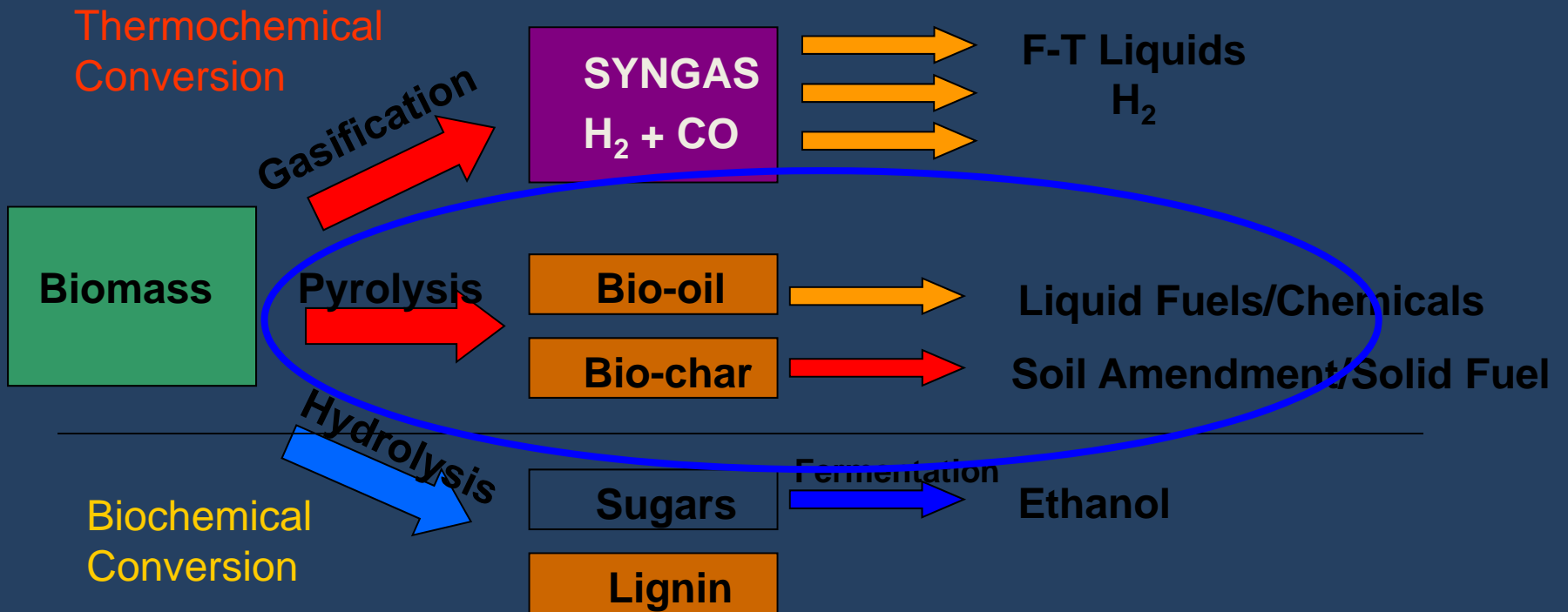


Physicochemical and Adsorptive Properties of Fast Pyrolysis Bio-Chars and Their Steam Activated Counterparts

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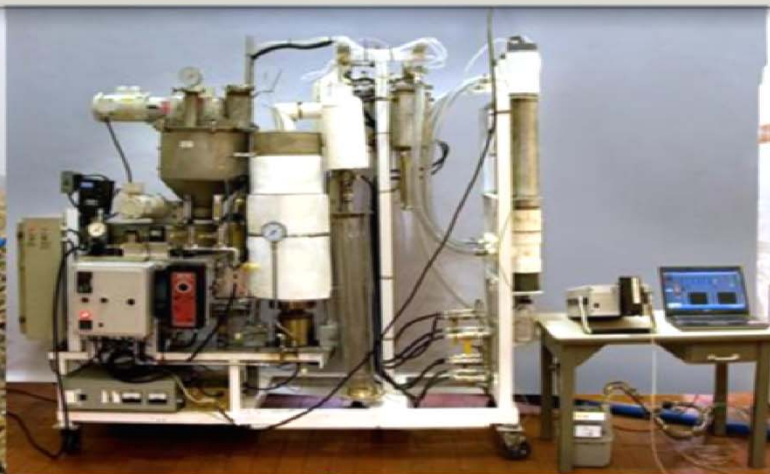
Biomass Conversion Pathways



Bio-Oil & Bio-Char Production @ ERRC



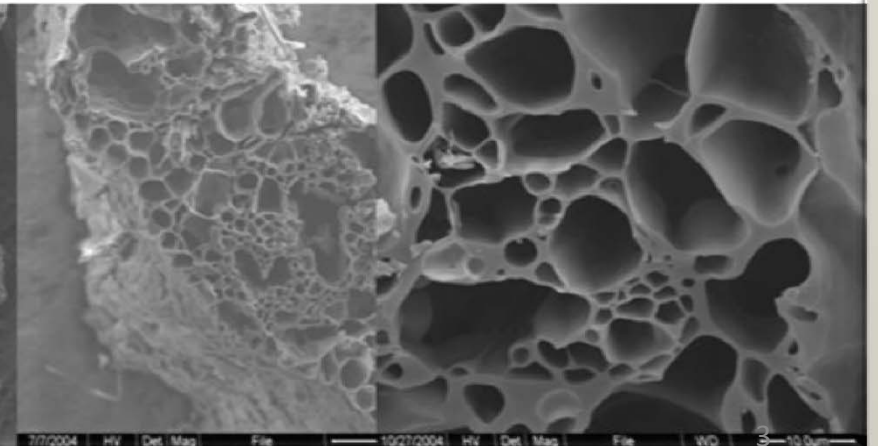
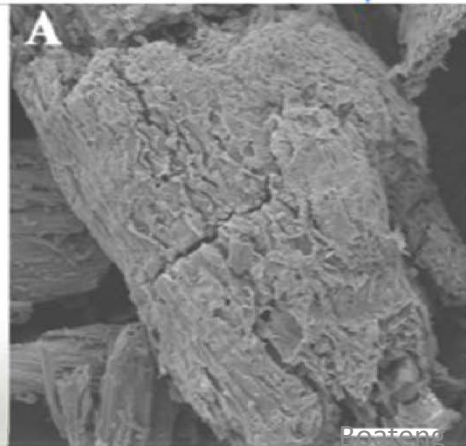
Bio-oil



Bio-char



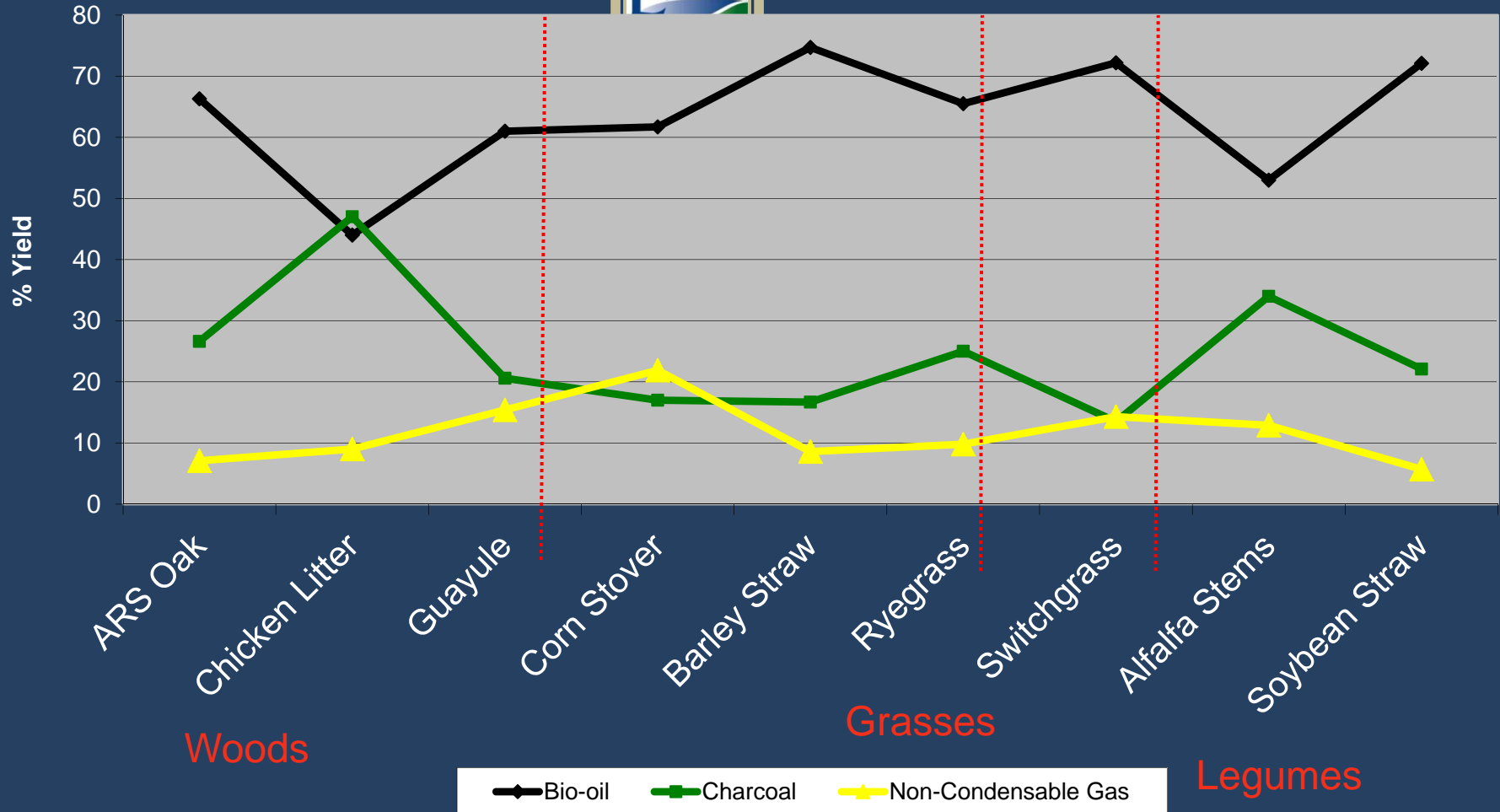
2010



ARS PYROLYSIS UNIT – The Kwesinator



Fast Pyrolysis Product Yields



Physical Properties



	ERRC Yield, %			M.C.	Bulk density
	Char	CUW	CW	%	g/cc
Broiler Litter	42.3	33.1	27.6	6.4	0.20
Switchgrass	13.5	8.1	5.4	10.6	0.46
Alfalfa	36.3	26.6	17.3	4.3	0.65
Corn cob	18.9	12.7		11.1	-
Corn stover	17.1	10.9	5.4	8.8	0.18
Guayule shrub	33.2	17.4	5.0	7.9	0.22
Guayule bagasse	20.6	12.3	6.6	8.2	0.21
Soybean straw	22.1	12.7	7.4	7.1	0.19

Char particle size, pH, Ash content



	PS, μm	pH	Ash, %
Broiler Litter	397	7.7	32.0
Switchgrass	246	8.7	58.0
Alfalfa stem	425	8.5	57.6
Corn cob	709	7.8	16.3
Corn stover	374	7.2	26.0
Guayule shrub	386	8.1	46.8
Guayule bagasse	372	8.3	23.5
Soybean straw	487	7.7	22.2

Surface Area

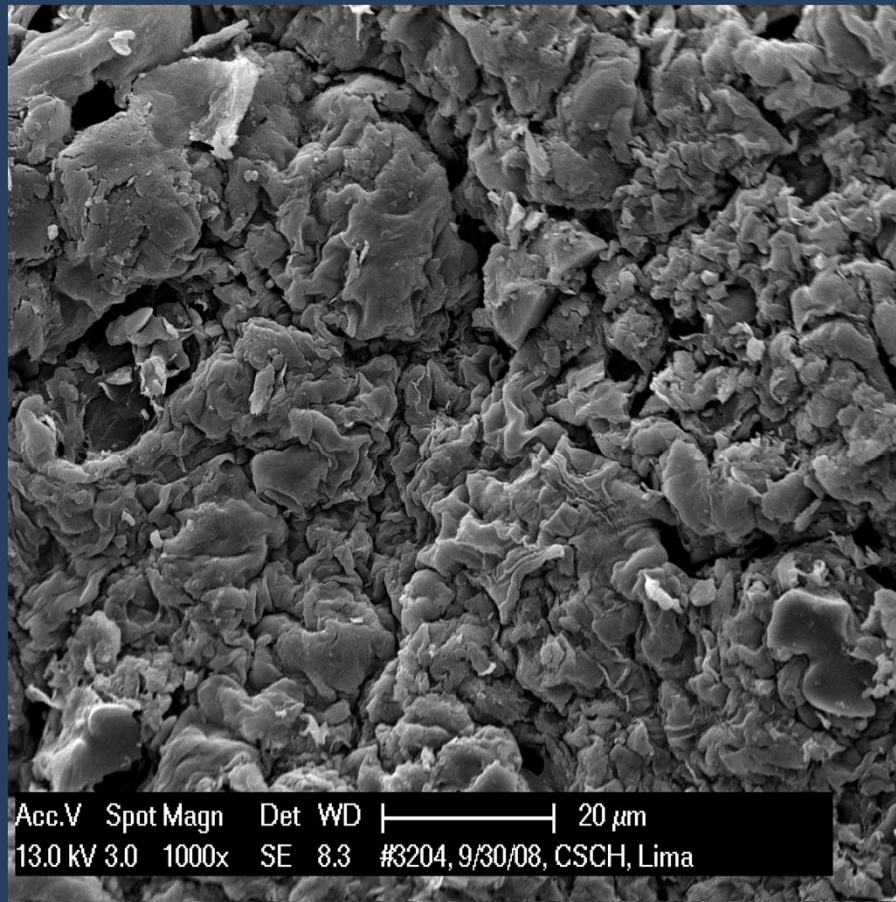


	BET, m ² /g		MV, cc/g		MP m ² /g
	Char	Carbon	Char	Carbon	
Broiler Litter	4.6	221	-	0.079	192
Switchgrass	0.3	283	-	0.102	251
Alfalfa stem	2.3	204	-	0.070	164
Corn cob	1.1	-	-	-	-
Corn stover	3.1	455	0.002	0.15	386
Guayule shrub	1.9	551	-	0.18⁹	436
Guayule bagasse	0.0	793	-	0.30⁷	734
Soybean straw	0.0	837	-	0.32⁶	743

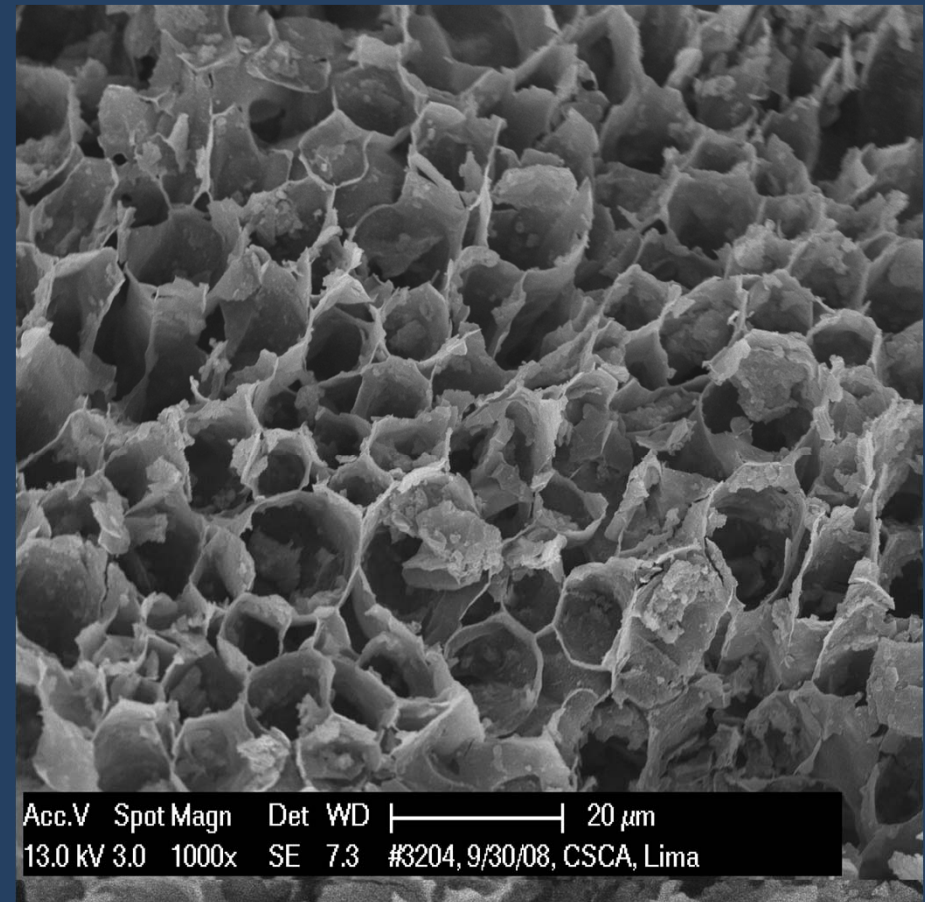
Corn stover



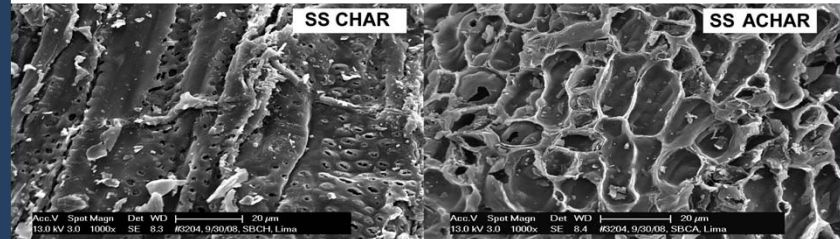
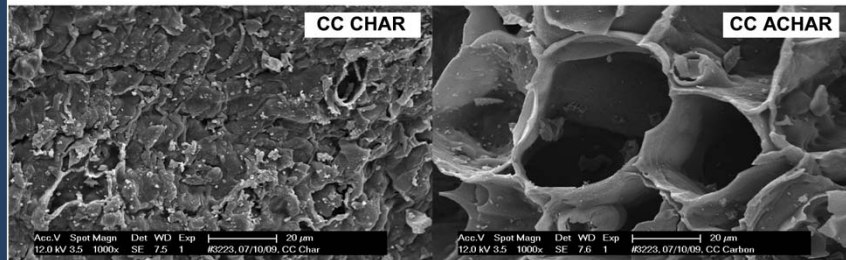
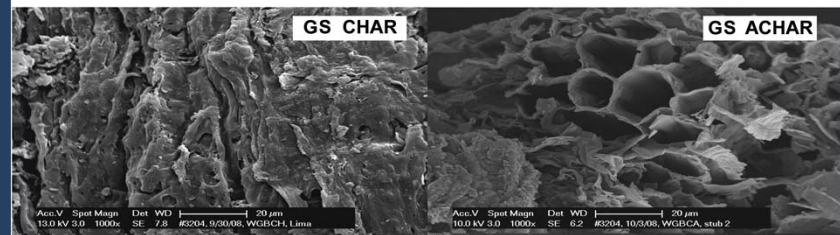
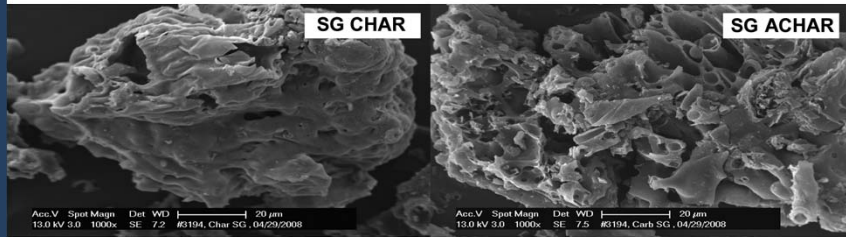
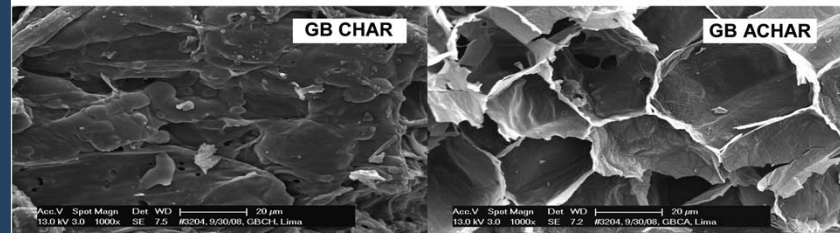
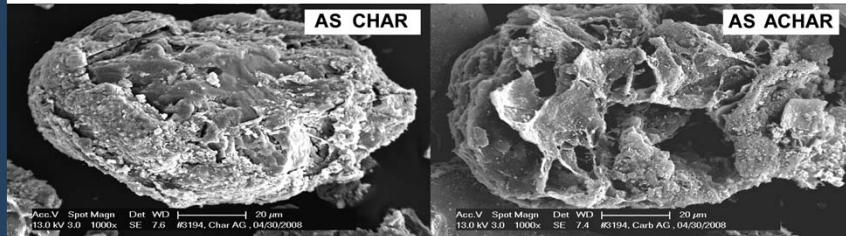
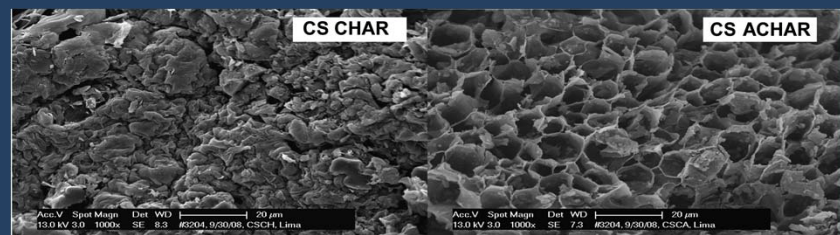
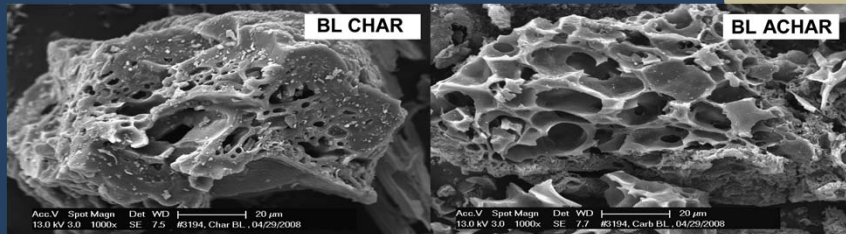
Char



Carbon



Scanning Electron Microscopy (SEM) photographs (1,000 magnification, bar = 20 μm)



Metal Ion Adsorption, 1mM - Biochar



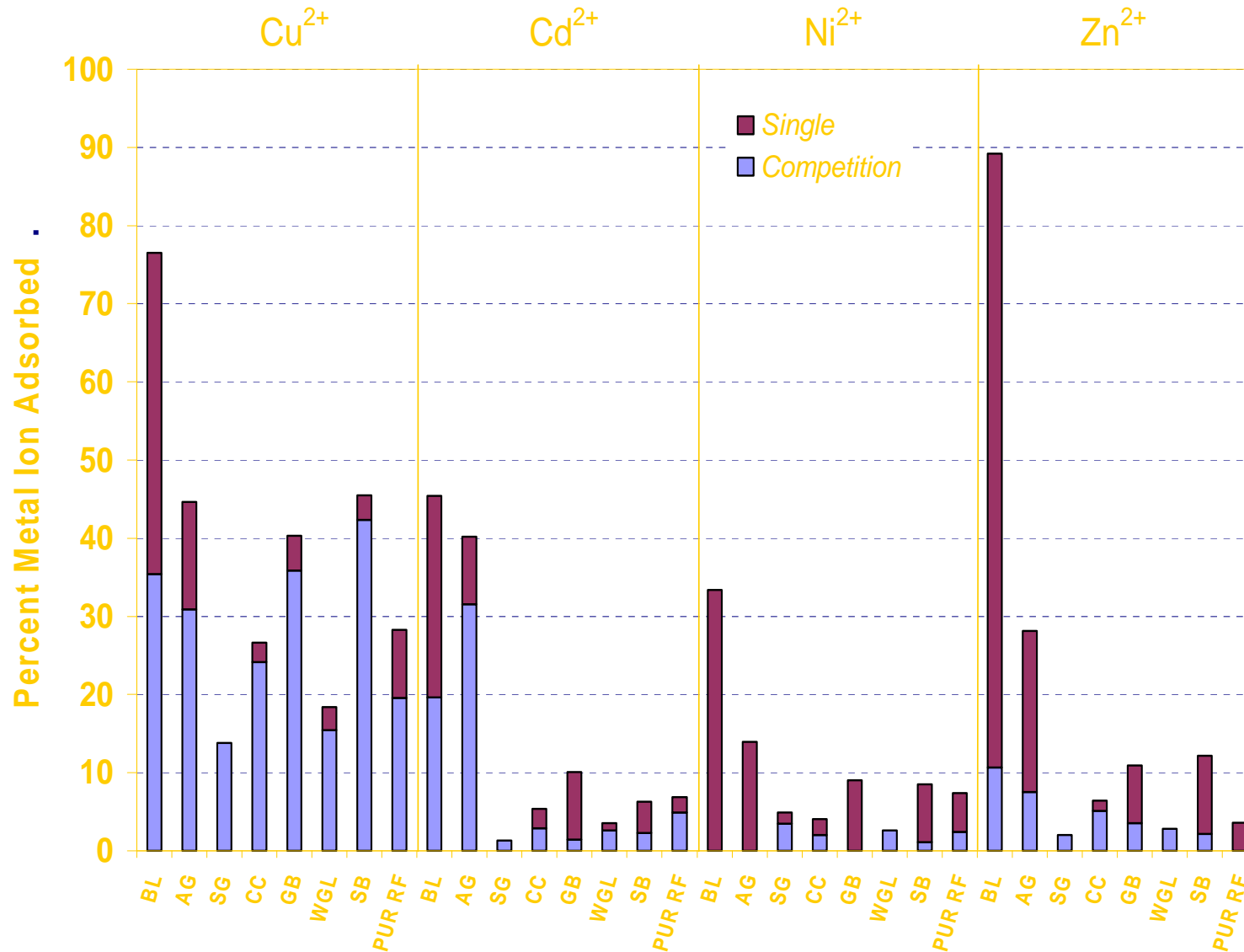
% Adsorption	Cu ²⁺	Cd ²⁺	Ni ²⁺	Zn ²⁺
Broiler Litter	75.2	21.7	10.1	16.4
Switchgrass	74.7	59.6	42.3	43.3
Alfalfa	59.7	44.3	22.8	46.9
Corn cob	54.5	22.6	12.3	21.3
Corn stover	80.3	31.1	29.2	37.2
Guayule shrub	85.6	83.2	86.6	85.0
Guayule bagasse	75.0	35.4	35.4	40.8
Soybean straw	84.6	53.8	49.5	48.1
PUR RF	51.0	17.1	29.2	15.2

Metal Ion Adsorption, 1mM - Carbon



% Adsorption	Cu ²⁺	Cd ²⁺	Ni ²⁺	Zn ²⁺
Broiler Litter	79.7	84.8	96.4	39.5
Switchgrass	46.8	16.5	-	21.0
Alfalfa	82.9	21.1	19.7	36.1
Corn cob	78.2	6.8	13.4	12.5
Corn stover	98.1	90.5	95.8	95.3
Guayule shrub	21.9	7.4	3.2	28.9
Guayule bagasse	93.2	18.4	22.4	14.9
Soybean straw	95.7	21.0	30.0	27.8
PUR RF	51.0	17.1	29.2	15.2

Competition Study - Carbon



Legend: BL: broiler litter; AG: alfalfa; SG: switchgrass; CC: corn cob; GB: guayule bagasse; WGL: guayule shrub; SB: soybean straw

Co-authors & Collaborators



Co-Authors

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