ANALYSIS AND UTILIZATION OF CONDITIONED AND BLENDED FUEL DERIVED COAL ASH

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ABSTRACT

Potential utilization of conditioned CCP fly ash is of considerable interest in some situations, for example due to lack of availability of suitable virgin ash, although the effects of conditioning on the pozzolanic quality of the ash must be addressed.

Blended fuel derived fly ash is becoming increasingly common although such ash falls strictly outside some definitions of CCP fly ash for cement powder replacement applications.

This paper presents physical and chemical property analysis of both conditioned and blended fuel derived ashes which have been subjected to Microwave Carbon Burnout processing and discusses their suitability in conventional ash applications.

ASHES USED IN TEST

Several ashes were selected for use in the test program as described in the following Table 1.

Table 1

Ash Description

Description	100% Coal	Blended Coal/Petcoke	Blended and Conditioned	Start LOI	Finish LOI
PG	●			4.5%	0.4%
BL1	●			8.7%	1.3%
OH1	●			9.1%	0.2%
BD1		85/15		13.5%	1.8%
BD2		75/25		10.8%	2.5%
BD3		85/15		8.5%	1.5%
BD4P2			●	17.5%	1.2%
BD4P1			●	17.5%	5.4%

The variable ratio blended ashes were produced by combining pure coal ash with metered quantities of pet coke; these were generated as reference samples to assist in identification of microscopic characteristics after LOI reduction. Sample BD4 (blended/conditioned) was processed in two stages (P1, P2) to yield an "intermediate" ash (BD4P1) having a finish LOI of 5.4% in order to observe the strength characteristics of this "upper limit" carbon content ash.

STRENGTH TEST ANALYSIS

Strength test data are presented in Table 2 below.

REFLECTED LIGHT MICROSCOPY

Reflected light microscopy of difference ash samples identifies some differences in morphology and apparent porosity with respect to the type of carbon (coal/petcoke)

Figure 1 shows separated carbon particles from unprocessed BL1 and OH1 samples, both derived from 100% coal ash. Carbon particles appear spherical, hollow and very porous in texture.

Figure 2 shows separated carbon particles from unprocessed BD2 as well as pet coke samples. Petcoke appears as glassy, spherical particles. BD2 particles appear to have some of the less porous texture of the pet coke particles although at this magnification (X15) the distinction between pet coke and non-petcoke derived ashes is not entirely clear.

Figure 3 shows a higher magnification of separated carbon particles from petcoke and unprocessed BD2, OH1 and BL1. The non-petcoke derived carbon (BL1, OH1) appears to have a rough, irregular shape whereas the BD2 sample includes more rounded shapes suggestive of petcoke.

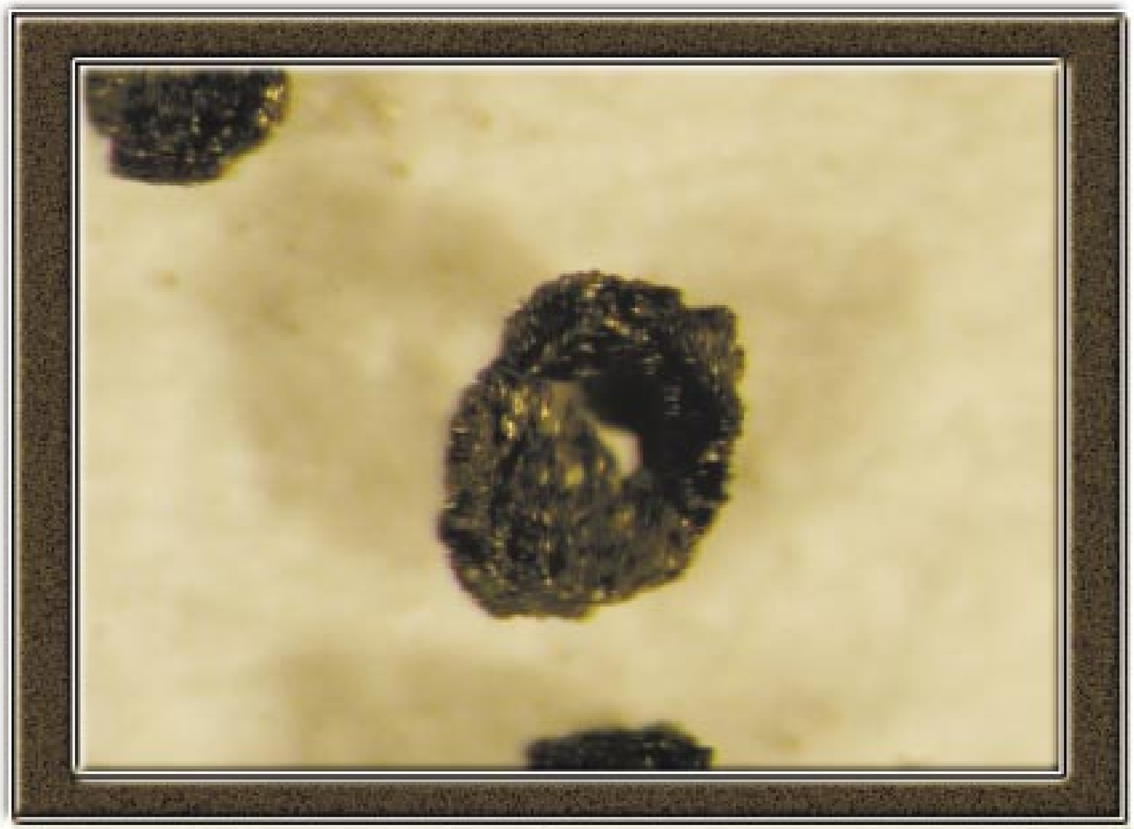
Figure 4 shows roaw ash samples (OH1, BD2) including carbon as well as other ash constituents. OH1 appears to show the porous, spherical carbon which is characteristic of non-petcoke ash; BD2 appears to include other less porous carbon particles which may be associated with petcoke.

Figure 5 shows BD4 ash in both the raw and processed states. Calcine (processed) material remains in the fluid bed reactor throughout the burnout process; cyclone (processed) material is less dense and characteristically is elutriated from the fluid bed during processing and is captured in the cyclone. In this instance, the calcine carbon particles appear to be the denser, less porous type associated mainly with petcoke; cyclone carbon is noticeably more porous and may be mainly associated with coal derived carbon.

Table 2

Strength Test Analysis

SAMPLE	BD4P1	BD4P2	PG	Specification Limits for Class F Fly Ash ASTM C618-98	CSA A23.5-98
Physical Requirements					
Strength Activity Index, % with Portland Cement					
- at 7 days	87.4	93.9	83.9	Min. % of Control, 75	N/A
- at 24 days	85.7	93.6	94.5	Min. % of Control, 75	Min. % of Control, 75
Fineness, % Retained on 45 µm sieve	15.1	10.4	15.1	Max. 34	Max. 34
Soundness, Autoclave Expansion or Contraction, %	-0.038	-0.028	-0.054	Max. 0.8	Max. 0.8
Water Requirement, % of control	97.1	97.5	97.1	Max. 105	N/A
Chemical Requirements					
$SiO_2 + Al_2O_3 + Fe_2O_3$, %	94.18 (56.73+ 30.18 + 5.27)	89.49 (58.48 + 19.73 + 11.28)	90.75 (56.33 + 29.17 + 5.25)	Min. 70	N/A
SO_3, %	0.65	0.06	0.06	Max. 5.0	Max. 5.0
Moisture Content, %	0.15	<0.01	0.15	Max. 3.0	Max. 3.0
Loss on Ignition, %	5.4	1.07	0.42	Max. 6.0	Max. 8
Available Alkalies, %	0.72	0.65	0.55	Max. 1.5	not specified
Specific Gravity	2.61	2.56	2.46	N/A	N/A



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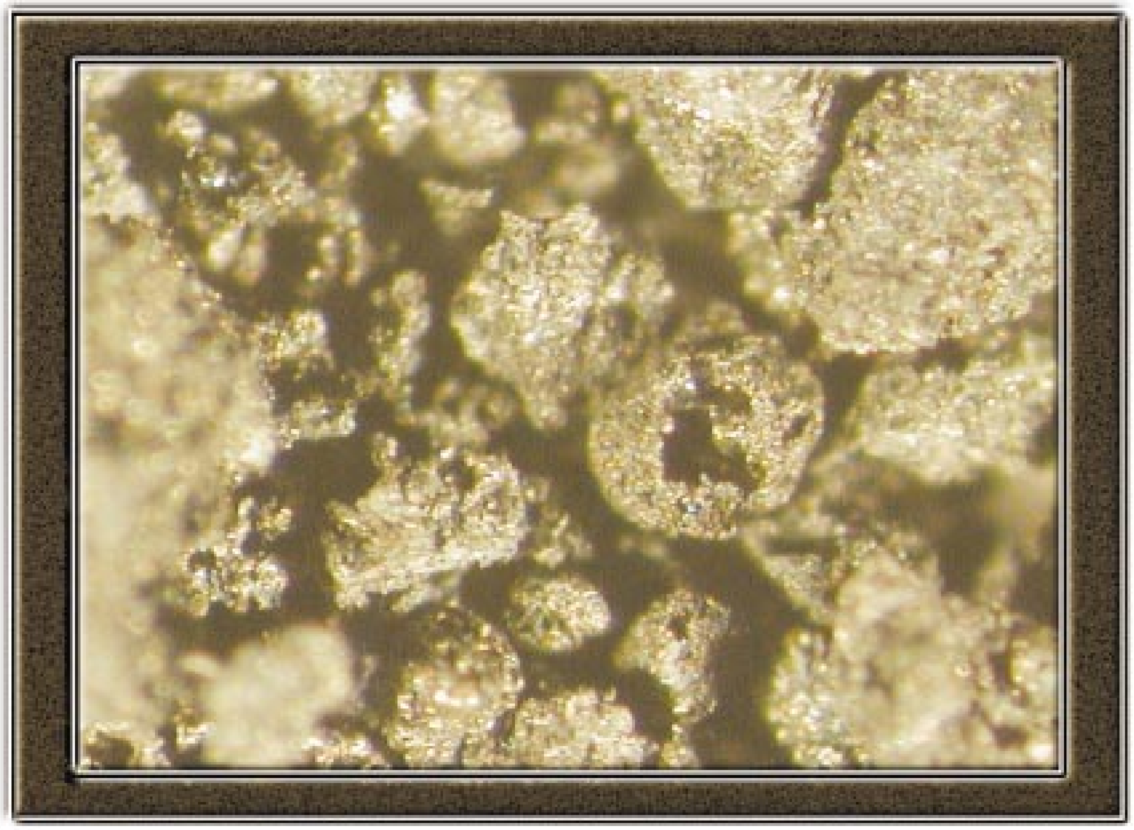
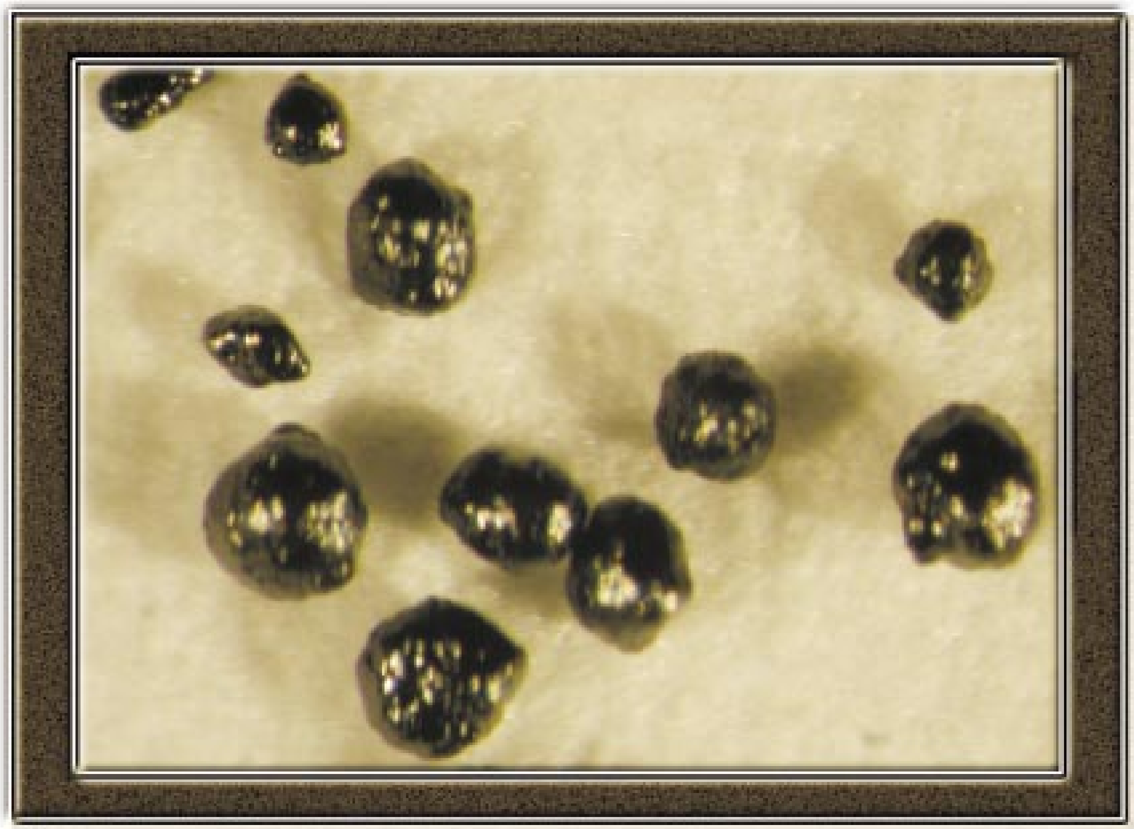
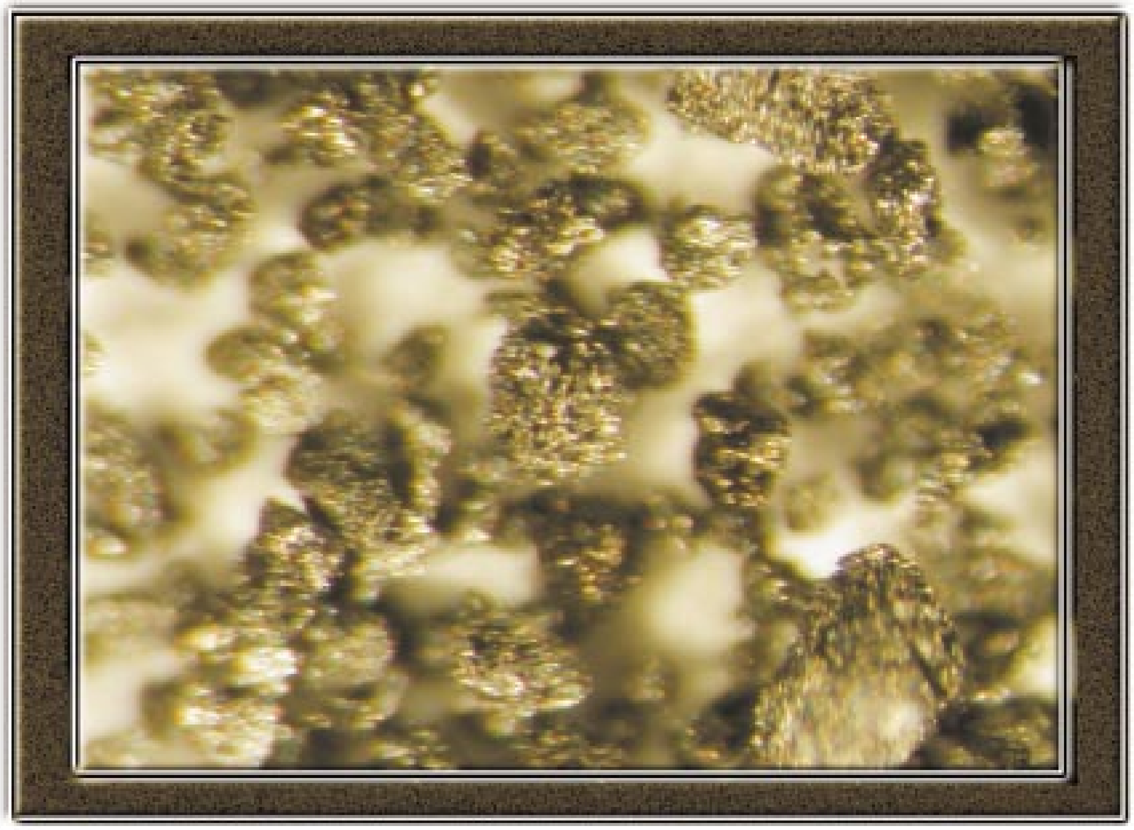


(b)

Figure 1. Separated carbon particles from (a) OH1 and (b) BL1; magnification X15



(a)



(b)

Figure 2. *Separated carbon particles from (a) petcoke and (b) BD2; magnification X15*

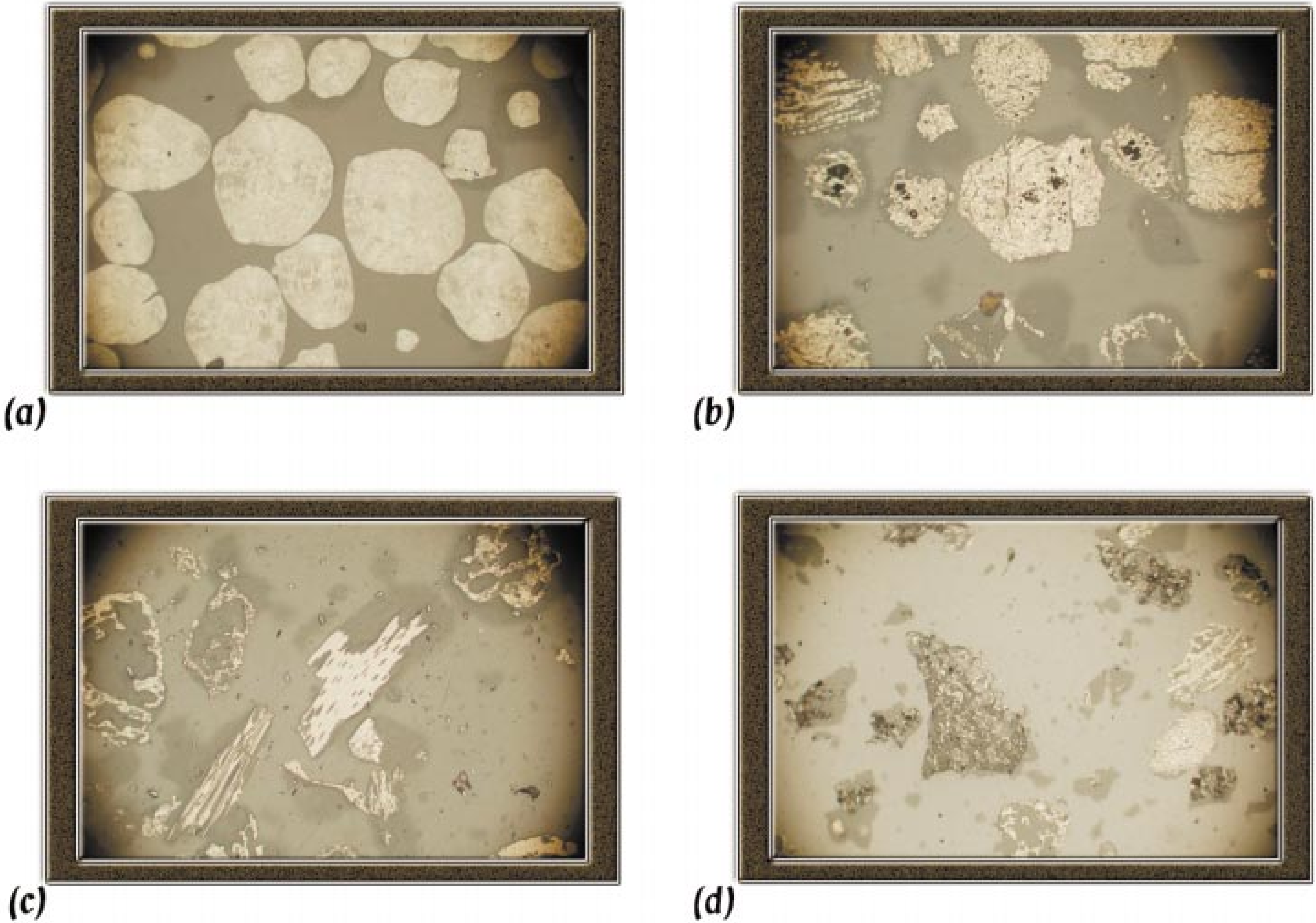
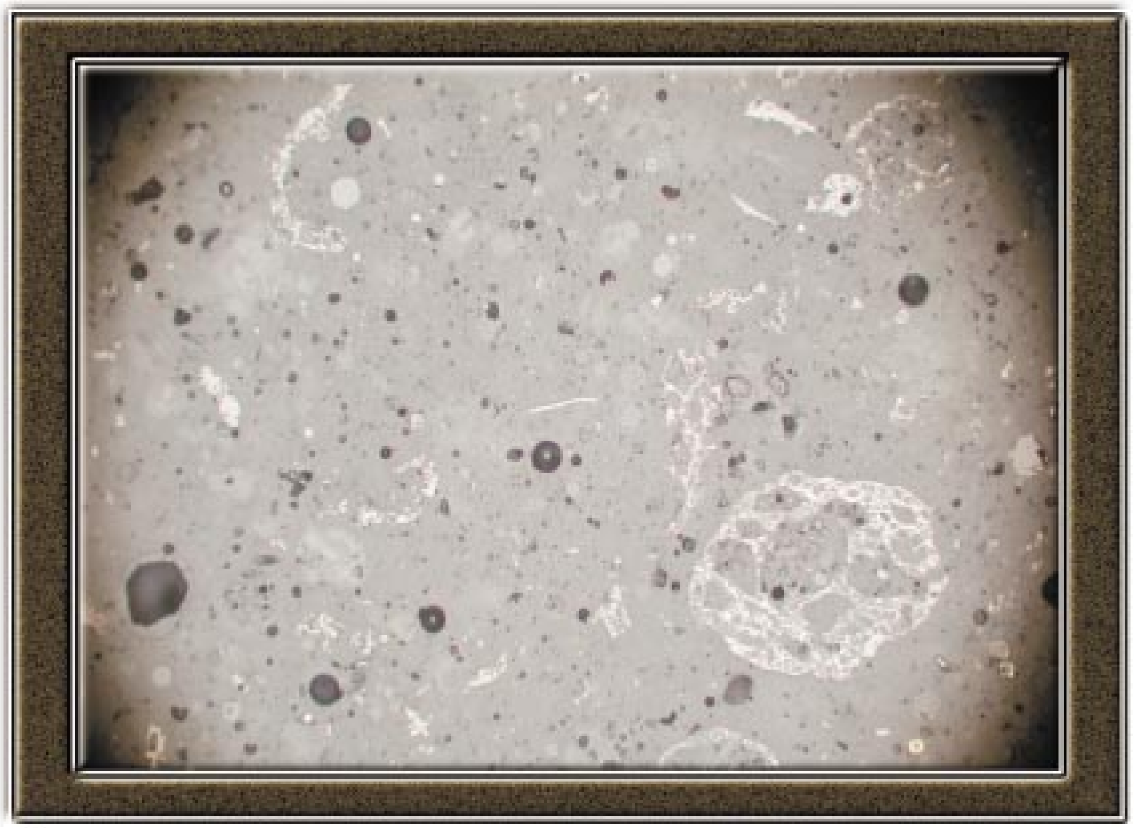


Figure 3. Separated carbon particles from (a) petcoke X200, (b) BD2 X200, (c) OH1 X200, (d) BL1 X100



(a)

(b)

Figure 4. Raw ash samples (a) OH1 X200, (b) BD2 X200

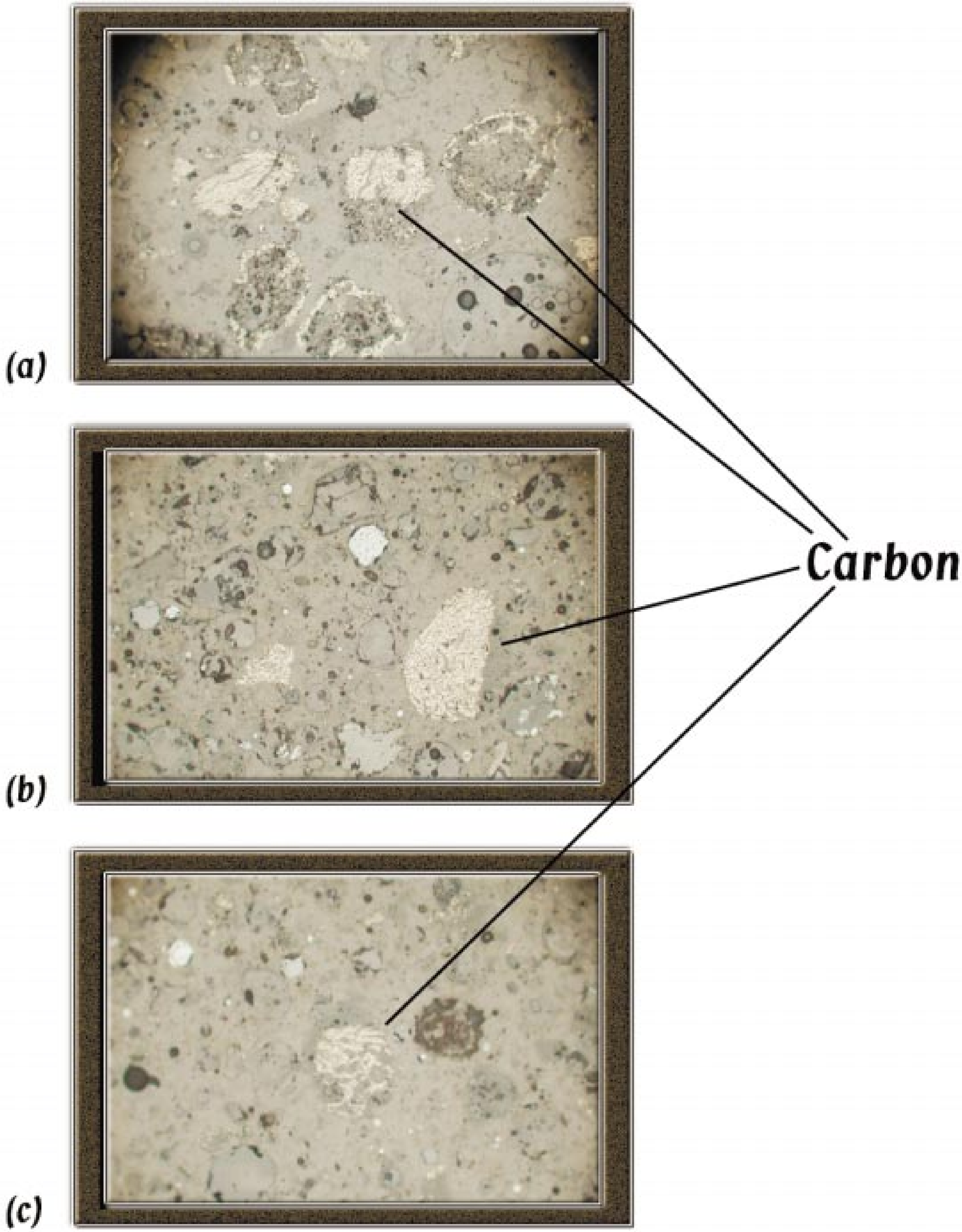


Figure 5. BD4 material in raw and processed states
(a) raw, unprocessed X200, (b) processed calcine X200
(c) processed cyclone material X200

CONCLUSION

Carbon present in both coal and blended fuel derived fly ashes after LOI reduction (carbon burnout) show some distinctions in shape and porosity characteristics although processed ashes from both sources fully satisfied the ASTMC618-98 and CSA A23.5-98 physical and chemical specifications.