Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

Electronic supplementary information

Exploring the Role of Solvent Polarity in Mechanochemical Knoevenagel Condensation: *In-situ* Investigation and Isolation of Reaction Intermediates

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Abstract: Mechanochemistry has proven to be a highly effective method for the synthesis of organic compounds, particularly for the tracking and isolation of relevant reaction intermediates. We studied the kinetics of the catalyst-free Knoevenagel reaction between 4-nitrobenzaldehyde and malononitrile, activated and driven by ball milling. The reaction was in the absence of solvents (neat grinding) as well as in the presence of solvents with different polarities (liquid assisted grinding). The reaction was monitored using time-resolved in-situ Raman spectroscopy and powder X-ray diffraction (PXRD). Our results indicate a direct relationship between solvent polarity and reaction kinetics, with higher solvent polarity leading to faster product formation (2-(4-nitrobenzylidone)malononitrile). For the first time, we were able to isolate and determine the structure of an intermediate 2-(hydroxy(4-nitrophenyl)methyl)malononitrile based on PXRD data.

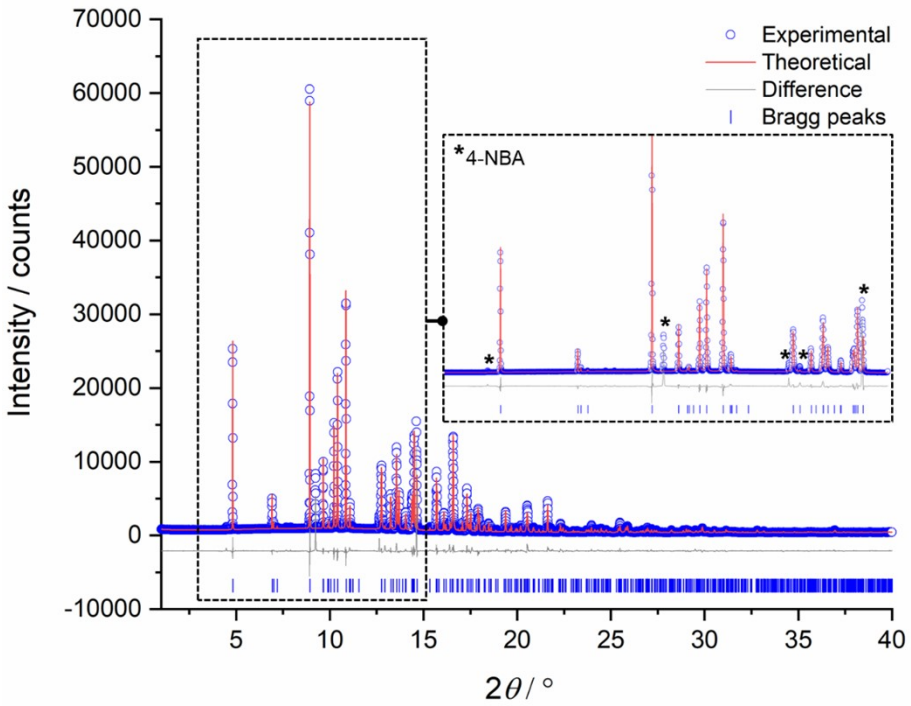

Figure S1. Rietveld refinement plot displaying the measured powder pattern (blue dots, λ = 0.8266 Å), the calculated powder pattern (red solid line), the difference curve (grey), and the reflection positions (Bragg peaks). An expansion is shown, highlighting (*) the peaks belonging to 4-NBA that were not fitted.

Table S1. Crystallographic details for 2-H-NMN without including 4-NBA starting material contamination.

	2-H-NMN
Chemical formula	$C_{10}H_7N_3O_3$
Formula weight/g.mol^{-1}	217.19
Crystal system	Monoclinic
Space group	$P\,2_1/c$
a/Å	10.89048(15)
b/Å	9.54267(14)
c/Å	10.63046(15)
β/°	115.6448(4)
V/Å^3	995.94(3)
Z	4
R_p, R'_p/%[1]	6.402, 14.440
R_{wp}, R'_{wp}/%[1]	13.003, 27.377
R_{exp}, R'_{exp}/%[1]	3.424, 7.208
R_{Bragg}	4.913
Gof	3.797

[1] Dashed values corresponds to values after background subtraction.

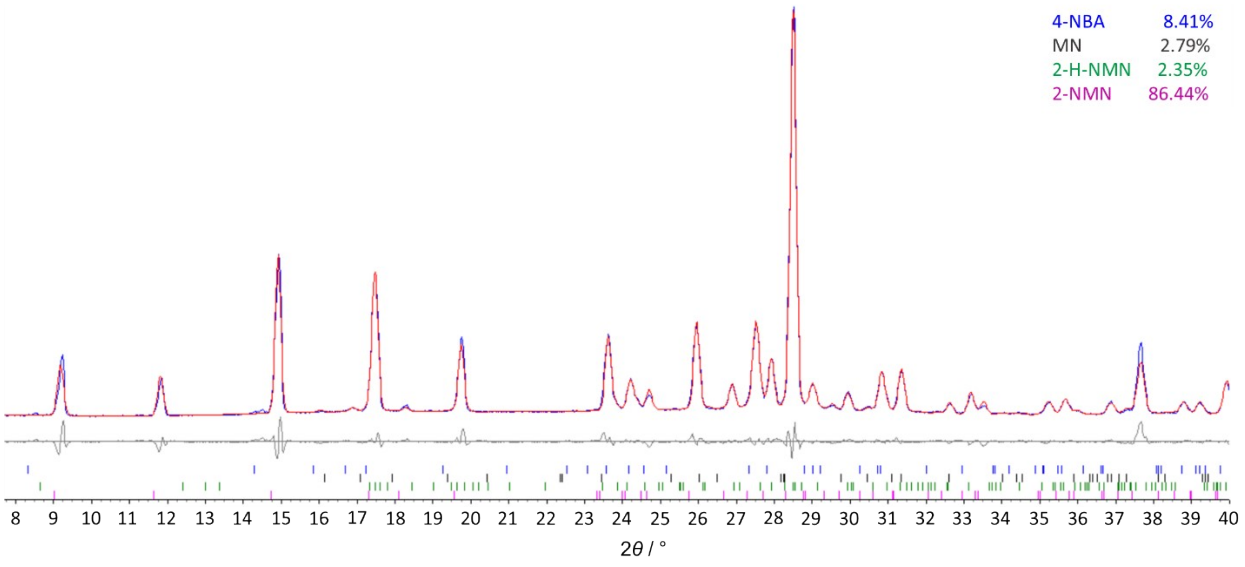

Figure S2. Quantitative phase analysis by Rietveld refinement after 13 min of ball milling in EtOH.

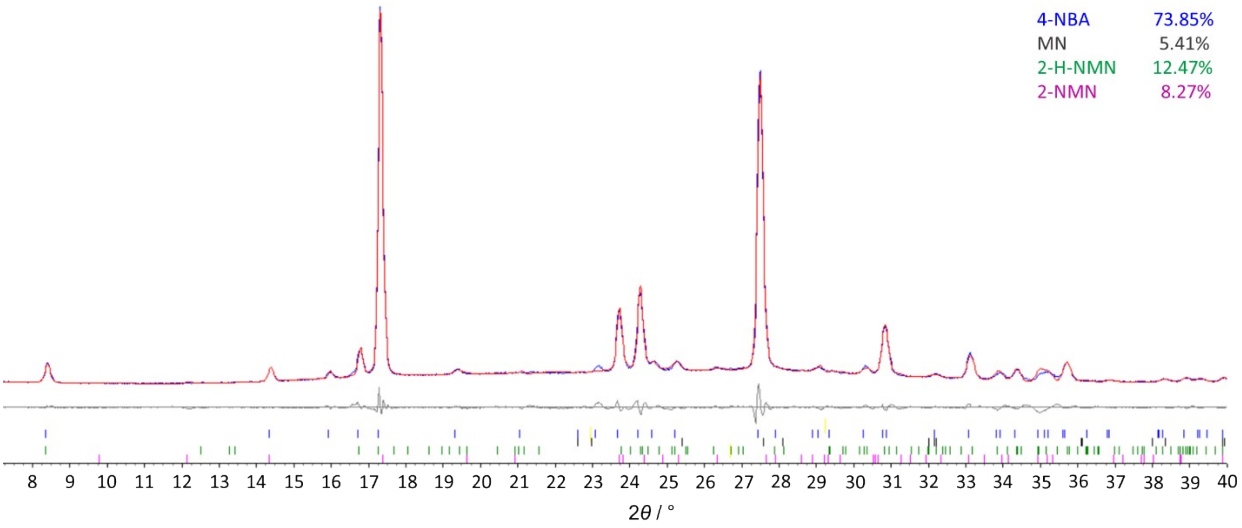

Figure S3. Quantitative phase analysis by Rietveld refinement after 13 min of ball milling in octane.